



**DRAFT  
STORMWATER AND RIVERBANK  
ASSESSMENT AND SAMPLING PLAN  
REVISION 4**

**REMEDIATION DESIGN SERVICES  
SWAN ISLAND BASIN PROJECT AREA  
CERCLA DOCKET NO. 10-2021-001**

**PORTLAND HARBOR SUPERFUND SITE  
PORTLAND, MULTNOMAH COUNTY, OREGON**

*Prepared for:*

**Swan Island Basin Remedial Design Group**

*Prepared by:*



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**September 2021**

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**Stormwater and Riverbank Assessment and Sampling Plan  
Swan Island Basin Project Area  
Portland Harbor Superfund Site**

**Record of Changes / Summary of Revisions**

<b>Revision No.</b>	<b>Revision Date</b>	<b>Document Name (If other than entire document, list revised sections or pages)</b>
0	September 15, 2021	Draft Stormwater and Riverbank Assessment and Sampling Plan
1	September 21, 2021	Revisions per client review comments
2	September 23, 2021	Revisions per EPA comments during September 22 site recon tour
3	September 23, 2021	Revisions per Funding Party comments
4	September 27, 2021	Draft for EPA review

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## LIST OF ACRONYMS AND ABBREVIATIONS

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°C	degrees Celsius
AECOM	AECOM Technical Services
ASTM	American Society of Testing and Materials
BANCS	Bank Assessment for Non-Point Source Consequences of Sediment
BEHI	Bank Erosion Hazard Index
BEHP	bis(2-ethylhexyl)phthalate
Bridgewater	Bridgewater Group
City	City of Portland
COC	contaminant of concern
CUL	cleanup level
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DDx	DDD+DDE+DDT
ECSI	Environmental Cleanup Site Information
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
ft	feet
GPS	global positioning system
HASP	Health and Safety Plan
HGL	HydroGeoLogic, Inc.
HVS	high-volume, time-weighted sampling
HxCDF	1,2,3,4,6,7,8-hexachlorodibenzofuran
ISCO	In Situ Chemical Oxidation
JSCS	Joint Source Control Strategy
L	liter
L/min	liter per minute
mg/L	milligram per liter
OCP	organochlorine pesticide
ODEQ	Oregon Department of Environmental Quality

## LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

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OU	Operable Unit
PCB	polychlorinated biphenyl
PDI	Pre-Design Investigation
PeCDD	1,2,3,7,8-Pentachlorodibenzo-p-dioxin
PeCDF	2,3,4,7,8-Pentachlorodibenzofuran
pg	picogram
pg/L	picogram per liter
PHSS	Portland Harbor Superfund Site
port	Port of Portland
PUF	polyurethane foam
QAPP	Quality Assurance Project Plan
RAL	Remedial Action Level
RD	Remedial Design
ROD	Record of Decision
RPC	recontamination potential chemical
SAR	Sufficiency Assessment Report
SIB	Swan Island Basin
SMA	Sediment Management Area
SOP	standard operating procedure
SRASP	Stormwater and Riverbank Assessment and Sampling Plan
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCDDeq	TCDD Toxic Equivalency
TCDF	2,3,7,8-tetrachlorodibenzofuran
TSS	total suspended solids
UFP	Uniform Federal Policy
USCS	Unified Soil Classification System

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## **1.0 INTRODUCTION**

HydroGeoLogic, Inc. (HGL) developed this *Stormwater and Riverbank Assessment and Sampling Plan* (SRASP) for the Swan Island Basin (SIB) portion of the Portland Harbor Superfund Site (PHSS). This plan describes the approach to field data collection that will characterize stormwater and riverbank conditions to support the evaluation of post-remedy recontamination of SIB sediments. The stormwater characterization will include physical inspection of municipal and private stormwater conveyance systems to verify proposed sampling locations and sampling of stormwater and solids. This sampling will provide the data necessary to evaluate stormwater loading and recontamination potential using the SEDCAM recontamination model. The riverbank assessment will be a survey of the riverbanks located along the perimeter of the SIB Project Area displayed on Figure 1-1. The riverbank assessment visual survey will document the physical condition of the riverbanks, identify locations where riverbank soil sampling is feasible, and collect data necessary to inform the use of the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model to evaluate the erodibility of the riverbanks. HGL conducted a site reconnaissance on September 23, 2021, to inform the development and planning of this SRASP.

The SRASP is an abbreviated planning document that is designed to expedite U.S. Environmental Protection Agency (EPA) review and approval of targeted field data collection efforts to begin in October 2021. The proposed work would be a component of the *Draft Pre-Design Investigation (PDI) Work Plan* that is currently in review and development (HGL, 2021a). This SRASP provides a means to accelerate EPA review and approval of seasonally dependent field work so that work may begin in October/November 2021 while allowing sufficient time to finalize the PDI Work Plan. Only the information that is specifically relevant to the assessment and sampling of stormwater and riverbanks is summarized below. The Field Sampling Plan (FSP) in the PDI Work Plan (HGL, 2021a) should be reviewed to determine the procedures for general tasks such as field documentation, decontamination, and data management. The remaining field work will be performed after EPA approves the final version of the PDI Work Plan.

## **1.1 SUPPORTING PLANNING DOCUMENTS**

The SRASP is supported by the SIB *Draft PDI Work Plan* (HGL, 2021a). The PDI Work Plan provides background information on the project, identifies the data gaps to be filled, and summarizes the data and information gathering tasks that will be conducted during the PDI to fill these data gaps. A brief description of each PDI Work Plan appendix that supports this SRASP is provided below.

- FSP, Appendix A of the PDI Work Plan: The FSP supports the PDI sampling within the SIB Project Area and the SIB Upland Area and provides details for field sampling locations and procedures for the planned PDI project tasks. The FSP also addresses the

field data collection needs identified in the Sufficiency Assessment Report (SAR) to inform the evaluation of potential recontamination.

- *Uniform Federal Policy (UFP)-Quality Assurance Project Plan (QAPP)*, Appendix B of the PDI Work Plan: Provides quality control elements to satisfy the data quality objectives for each task specified in the PDI Work Plan. The protocols established in the UFP-QAPP are necessary to ensure the data generated is of a sufficient quality to support development of valid conclusions.
- *Health and Safety Plan (HASP)*, Appendix C of the PDI Work Plan: Identifies and describes physical, chemical, and biological hazards relevant to each planned field task, and provides hazard mitigation techniques to address these hazards.
- *Emergency Response Plan*, Appendix D of the PDI Work Plan: The Emergency Response Plan will be used in the event of an accident or emergency during performance of the Remedial Design (RD) work.

Upon receiving EPA approval of this SRASP, the finalized text from Section 4 (Field and Sampling Activities) will be incorporated into the final version of the PDI Work Plan, which is planned for submittal in late Fall 2021.

## 1.2 PURPOSE AND OBJECTIVES

This SRASP describes the sampling methodologies and strategies that will be employed to achieve the objectives outlined in the PDI Work Plan. The five principal data gap objectives of the PDI are summarized below and detailed in Section 2.

1. Define the specific data and analysis needs required to fully inform the design development and evaluation based on a conceptual design approach and strategy consistent with the Record of Decision (ROD).
2. Compile and evaluate existing available data and analysis relevant to the defined data and analysis needs as determined by the design requirements.
3. Identify data gaps by comparing what is needed to what is available.
4. Develop a work plan to guide the collection of new data and the completion of new analyses to address the data gaps.
5. Ensure that the analysis needs are sufficient to support the Administrative Settlement Agreement and Order on Consent applications required for Sediment Management Area (SMA) refinement, conceptual site model refinement, and effective use of the technology application decision tree (Figure 1-2). As such, PDI surface sediment sampling will be completed to refine the lateral extent of contaminants of concern (COCs).

In this SRASP, “SMA” describes SIB Project Area sediments for which Remedial Action Levels (RALs) were exceeded and where a remedial technology of dredging or capping was assigned in the PHSS ROD (Figure 1-2) (EPA, 2017).



## 2.0 DATA GAP ANALYSIS

The data gap analysis was completed as part of preparing the PDI Work Plan using the following approach:

1. Identify the data and analysis needed, based on the conceptual design approach and strategy, to inform the development and evaluation of an RD for a sustainable and effective remedy;
2. Compile and evaluate available applicable data and analysis aligned with the specified data and analysis needs; and
3. Identify data and analysis gaps based on the comparison of what is needed to what is available.

The stormwater discharge and riverbank characterization data gap analyses are detailed below and summarized in Table 2-1. The component of the riverbank data gap analysis pertaining to riverbank soil chemistry will be completed after the first phase riverbank assessment survey is completed. That analysis will support preparation of a riverbank soil sampling plan to be conducted as a second phase of the overall riverbank characterization.

### 2.1 STORMWATER DISCHARGE

There are five City of Portland (city), seven Port of Portland (port), and approximately 44 private stormwater outfalls that discharge to the SIB Project Area from the surrounding upland areas. The upland drainage areas and outfalls that discharge to SIB are illustrated on Figure 2-1. The status of discharges from some of the private outfalls is unknown and will need to be evaluated as part of the PDI to provide information necessary to complete the SAR (HGL, 2021b). ROD Table 17 COCs including SIB recontamination potential chemicals (RPCs)<sup>1</sup> were detected in stormwater and stormwater solids in public and a subset of the private outfall basins at concentrations that exceed the surface water and/or sediment cleanup levels (CULs) and/or RALs. In addition, dioxins/furans have not been adequately characterized either within the public stormwater conveyance systems, or at the many private sites in the upland area around the SIB Project Area that are contributing runoff to the SIB Project Area.

For the reasons above, the collection of additional source control data within city outfall basins M-1, M-2, M-3, S-1, and S-2, and select active, private outfall basins, is necessary to determine source control sufficiency to complete the SAR and for modeling to assess recontamination potential for SIB (HGL, 2021b). The specific data collection and analysis approach to evaluate inputs from upland sites, and current discharge RPC concentrations for the outfalls, are provided in Section 3.1. Completion of the ongoing source control and investigation activities at upland properties continues to be within the jurisdiction of the Oregon Department of Environmental Quality

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<sup>1</sup> SIB recontamination potential contaminants are PCBs; dioxins/furans (TCDDeq, HxCDF, PeCDD, PeCDF, TCDD, and TCDF); pesticides (dieldrin, DDX, total chlordane); metals (arsenic, mercury); diesel-range petroleum hydrocarbons; and bis(2-ethylhexyl)phthalate (BEHP).

(ODEQ) with coordination and input from EPA on upland contamination that may impact the Willamette River.

## 2.2 RIVERBANK CONDITIONS

The ROD defines riverbanks as areas from top of bank down to the river (mean lower low water). Figure 4 in the *Guidance for River Bank Characterizations and Evaluations at the Portland Harbor Superfund Site* (EPA, 2019) presents a flow chart outlining the riverbank evaluation and sampling process for PHSS. It outlines site-specific riverbank sampling and evaluation process for SIB ROD riverbanks and ROD riverbanks pending characterization. EPA has assumed oversight of the riverbank erosion pathway from ODEQ. The ROD (EPA, 2017) identified three sections of riverbank within the SIB Project Area as areas with known contamination. The locations of those riverbanks are shown on Figure 2-2 and described as follows:

- Two adjacent riverbanks along the Portland Shipyard and Port of Portland properties on Swan Island adjacent to the SIB Project Area (Environmental Cleanup Site Information [ECSI] 277);
- The riverbank along the Portland Shipyard property on the end of the Swan Island peninsula; and
- One riverbank along the U.S. Navy and Marine Reserve Center (ECSI 5109) in the Mocks Bottom portion of the SIB Upland Area.

The SAR assigned an initial source control sufficiency status of “uncontrolled” to all shoreline properties because (1) few riverbanks adjacent to the SIB Project Area have been adequately characterized (SAR Figure 6-1 [HGL, 2021b]); (2) there is a potential need for Remedial Action on shorelines where COCs are present in soils, and; (3) contaminated riverbanks are at risk of erosion and could be uncontrolled sources of recontamination. If an in-river sediment SMA does not extend to the toe of the riverbank in portions of the SIB shoreline (i.e., is not contiguous with the riverbank) and the riverbank materials are not erodible, the source control sufficiency status may be downgraded for the riverbank erosion pathway in those areas as further discussed in Section 3.2 of this SRASP.

Data was not available to adequately characterize riverbank stability and the presence of COCs in riverbank soil necessary to determine their source control sufficiency status, identify riverbank locations that would need to be addressed as part of the RD, or inform design development for riverbank remediation where required. Section 3.2 of this SRASP describes the objectives of the proposed field survey and data to be collected to address riverbank data gaps.

The RD will include measures to stabilize the three ROD riverbanks and other riverbanks within the SIB Project Area that are contiguous with SMAs with an active remedy component that are part of RD. The selected remedy for riverbanks will minimize erosion and transport of riverbank materials contaminated above CULs, thereby minimizing recontamination potential via this pathway. Alteration of any riverbank will be discussed and coordinated with shoreline property owners during the RD.

### **3.0 PRE-DESIGN INVESTIGATION APPROACH**

The data gap analysis (Section 2.0) identified data gaps to be filled during the PDI. Section 2.1 identified stormwater data gaps related to RPC loading rates from public and private outfalls discharging to the SIB. Those data are needed to (1) determine source control sufficiency to complete the SAR, (2) support modeling analysis to assess recontamination potential related to the stormwater pathway. Section 2.2 identified riverbank data gaps related to physical conditions of riverbanks, riverbank stability/susceptibility to erosion, presence, and concentration of COCs in riverbank soil. Those data are needed to (1) determine the source control sufficiency status of riverbanks (as potential sources of recontamination), (2) identify riverbank locations that need to be addressed as part of the RD, and (3) inform design development for riverbank remediation where required. This data is required to support development of the RD. In addition to informing RD development, components of the PDI will also support completion of the source control sufficiency assessment as documented in the SAR (HGL, 2021b), SMA delineation refinements, refinement of the conceptual site model, and application of the Technology Application Decision Tree (Figure 1-2) to determine remedial technology assignments. Data gaps are summarized in Table 2-1 along with the proposed data collection and analysis recommended to address those gaps. Data gaps will be addressed using a combination of field data collection (e.g., sampling and surveying) and engineering analysis. This section describes the approach to both the field sampling efforts and engineering studies for the stormwater and riverbank pathways.

#### **3.1 STORMWATER OUTFALL AND CONVEYANCE SYSTEM SAMPLING**

This task includes the collection of stormwater and stormwater solids samples within municipal and private conveyance systems that drain to the SIB Project Area. Proposed sampling of municipal conveyance systems will include city M-1, M-2, M-3 S-1, and S-2 outfall basin conveyance systems and seven private conveyance systems. Sampling near the municipal outfalls (but above the river stage and groundwater elevation) will help determine current ongoing ROD CUL and SIB RPC concentrations and loads to SIB. Some ROD COCs, including SIB RPCs, in stormwater and stormwater solids were detected in city outfalls at concentrations exceeding surface water and sediment CULs and/or RALs. As further described in Section 6.1 of the SAR (HGL, 2021b), evaluation of available data indicates that additional sampling within city and private outfall basins is warranted, due to:

- Available stormwater solids data showed that polychlorinated biphenyls (PCB) concentrations exceeded the CUL in all SIB city outfall basins and the PCB RAL in some locations;
- While data for stormwater and stormwater solids is available for all SIB city outfalls, no recent data is available to establish “baseline” conditions to estimate potential recontamination of future remedial caps and enhanced natural recovery and monitored natural recovery areas;
- Stormwater and stormwater solids COC and RPC concentrations in the SIB, which, although similar to other PHSS heavy industrial sites, still exceed the applicable surface water and riverbank/sediment CULs; and

- Private outfalls with no stormwater or solids data are adjacent to COC and RPC concentration exceedances in surface sediment.

In addition, dioxins and furans are present in surface sediment in the vicinity of the city and private outfalls. However, to date, dioxins/furans have not been adequately characterized either within the stormwater conveyance systems, or at the many sites in the SIB Upland Area that are contributing stormwater to these conveyance systems and/or directly discharging into the SIB Project Area.

This SRASP includes a task to identify and describe additional stormwater data collection to facilitate an understanding of the potential ongoing discharge to the river of current ROD COCs and SIB RPCs at concentrations that exceed CULs and/or RALs. Figure 3-1 shows the proposed stormwater sample locations within city M-1, M-2, M-3, S-1, and S-2 outfall basins. Table 3-1 summarizes invert elevations of proposed sampling locations in the city's system as well as possible alternative sample locations representative of basin discharges, if access constraints or possible backflow are identified. Most SIB outfalls are submerged at least part of the year, causing flow reversals within the pipe, which would confound stormwater loading evaluations. Due to this condition, the manhole access location closest to the target outfalls was selected as the representative "End of Pipe" sample location for proposed high-volume, time-weighted sampling (HVS) (i.e., manholes AAM107, AAM169, AAQ003, AAP957, and AAM131).<sup>2</sup> Advance field reconnaissance will identify fallback HVS sampling locations if during a larger storm event the proposed manholes are flooded to the point that the proposed sampling would be infeasible at those locations. The HVS sampling methodology using the Gravity Marine PR2900 system is a time-weighted sampling method that targets sampling during the highest flow periods of a sampling event. The HVS method will target qualifying storms that occur during periods when the river stage is below the manhole elevation, which is expected to ensure the sample is representative of stormwater discharge and is not influenced by river water backing up into the pipe.

HVS at these key locations will include the collection of time-weighted stormwater, stormwater solids, and storm flow data during three representative storm events over an approximate 9-month period to predict future total cumulative loading to the SIB Project Area via use of the SEDCAM recontamination model. In addition, flow meters and in-line sediment traps will be installed in sub-basin laterals to the manholes to collect continuous data that will be composited into two separate sampling periods (wet season from November 2021 through March 2022 and dry season from July through October 2022) for comparison to the data collected during the three individual HVS storm events. Prior to deployment, HGL will confirm that sampling and instrument deployment will occur in manholes when river elevations are sufficiently below manhole elevations.

This SRASP also includes the collection of manual grab samples at the same locations as the in-line sediment traps (prior to deployment) and at manholes further up-pipe within the city conveyance system. The rationale for collecting manual grab samples from laterals in sub-basins

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<sup>2</sup> High-volume water samples are collected to quantify concentrations of targeted organic chemicals (e.g., dioxins/furans, PCBs, and pesticides) that could be present at levels too low to be detected using conventional sampling methods. This method also allows for quantification of hydrophobic organic chemicals in the suspended particle and dissolved phases of the water column. EPA approved the HVS equipment system, the Gravity Marine PR2900, for use on the PHSS PDI and baseline sampling surface water sampling event (AECOM and Geosyntec, 2019). This sampling methodology is a form of flow-weighted sampling.

of each city outfall basin, prior to sediment trap deployment, is to collect any materials present in the line in the unlikely event that no solids are collected in the sediment traps; these solids will be archived (frozen) for potential future analyses. This sample collection, as well as the sediment trap data, will be used as inputs to the SEDCAM recontamination model to inform the relative ROD COC and SIB RPC load from each major sub-basin (i.e., each sub-basin of the outfall basins in the city conveyance system) and will identify potential ongoing sources of contamination by evaluating stormwater solids data downstream of various upland industrial sites. Refer to Appendix A of the SAR for more detail on the SEDCAM modeling approach specifically regarding how stormwater data will be used to calculate mass loading of COCs into the SIB.

The sampling locations proposed for in-line and grab stormwater solids are shown on Figure 3-1 and listed in Table 3-1, and include:

- Three laterals into manhole AAM104 from sub-basins in city M-1 outfall basin (map identification is OFM-1);
- Three laterals into manhole AAM169 from sub-basins in city M-2 outfall basin (map identification is OFM-2);
- One lateral into manhole AAQ003 within city M-3 outfall basin and grab samples from one manhole (AAQ011) where PCB-impacted solids may be entrained in road runoff via off-site tracking from ECSI 44;
- Two laterals entering manhole AAM131 within city S-1 outfall basin; and
- Two laterals entering manhole AAP957 within city S-2 outfall basin.

In addition to city conveyance system monitoring, private systems will be instrumented with autosamplers to collect grab samples and flow data during qualifying 2005 ODEQ and EPA Joint Source Control Strategy (JSCS) guidance storm events to assess the need for upland source control (Figure 3-1). The private stormwater systems with direct discharges to SIB to be sampled and the rationale for sampling each system include:

- The U.S. Coast Guard Marine Safety Unit (historical CUL exceedances in stormwater and stormwater solids and adjacent to RAL and principal threat waste threshold exceedances in sediment);
- Port Dredge Base (no data available and adjacent to CUL exceedances in sediment);
- ATC Leasing (historical CUL exceedances in stormwater and adjacent to RAL exceedances in sediment);
- Barge Eagle Inc./Swan Island Dock Company (historical CUL exceedances in stormwater and adjacent to CUL exceedances in sediment);
- North Basin Watumull LLC/Swan Island Dock Company (no stormwater or stormwater solids data, historical pesticide releases, and adjacent to RAL exceedances in sediment);
- Daimler Trucks North America Corp 5 Wind Tunnel property (no stormwater or solids data and adjacent to RAL exceedances in sediment); and

- Port property on N. Lagoon Avenue, the former Swan Island Upland Facility Operable Unit (OU) 3 (historical CUL exceedances in stormwater and stormwater solids, discharges to ROD riverbank, and adjacent to RAL exceedances in sediment).

While ROD COC and SIB RPC exceedances are present in surface sediment adjacent to the Portland Shipyard, Vigor Industrial LLC is implementing source control measures under an ODEQ Consent Order and Tier 2 measures under its National Pollutant Discharge Elimination System 1200-Z stormwater permit to control CUL exceedances discharging in stormwater. Vigor Industrial LLC is also sampling stormwater for dioxin/furans pursuant to the ODEQ Consent Order (Floyd|Snider, 2020). The Portland Shipyard outfalls historically discharging to the basin in the SIB Project Area include 2 outfalls rerouted for treatment in 2017, and 18 outfalls that will be rerouted for electrocoagulation treatment in 2021. Two additional outfalls that discharged to the Portland Shipyard's drydock area were rerouted for treatment in 2017. Treated effluent from the rerouted outfalls discharges to the main channel of the Willamette River at berth 313 (see Figure 3-1 for berth 313 location).

For upland source tracing for PCBs in the city M-3 outfall basin, HGL proposes to collect solids from manhole AAQ011 (Figure 3-1). This location is proposed for solids grab sampling in the stormwater system to determine if PCBs are being tracked from the adjacent property at 3205 N. Webster Street and migrating to SIB via city outfall M-3 discharges. This site is a former ODEQ cleanup site that formerly dismantled transformers, where PCBs were detected in soil. The site was paved and ODEQ issued a no further action determination in 1992. However, PCBs were detected in solids around this site and along N. Emerson Street to the north in 2013 (Bridgewater, 2013).

Additional data on the proposed sample locations, sampling methodology, analytical approach, and schedule is provided in the FSP (Appendix A of the PDI Work Plan [HGL, 2021a]) and UFP-QAPP (Appendix B of the PDI Work Plan [HGL, 2021a]).

### **3.2 RIVERBANK CHARACTERIZATION**

Riverbank characterization is needed to fulfill two purposes: (1) address data gaps necessary to complete the source control sufficiency assessment, and (2) provide data necessary to support RD for remediation of contaminated riverbank soils.

Riverbank characterization will be performed in two phases with two separate field mobilizations to identify and characterize the types of bank materials present at the site, locate and delineate areas of potentially erodible sediments, sample grain sizes (through subsequent laboratory sieve analysis), and locate areas of geotechnical movement (slope rotational failure, settlement). This SRASP includes only the first phase. The first phase will include an assessment survey of the entire riverbank within the SIB Project Area and completion of a bank stability analysis using the BANCS model including Bank Erosion Hazard Index (BEHI) and near bank stress determinations. The first phase of the proposed riverbank characterization includes visually inspecting the riverbank and material types to determine input parameters for the BANCS evaluation. After this first phase riverbank assessment survey, HGL will prepare a riverbank soil sampling plan as an addendum with the data quality objectives and proposed sampling locations. The first phase

assessment survey would be performed when water levels are at their lowest in SIB (anticipated for Fall 2021 or early 2022).

The proposed two-phased characterization will develop data required for determining which riverbank areas need further detailed erodibility/stability assessments by coastal and geotechnical engineers during the PDI. This data also will be used to delineate riverbank areas susceptible to erosion for future use in the RD. Coordinates of erodible and non-erodible areas will be mapped using hand-held global positioning system (GPS), backed up with field notes on tablets. During the second phase of the riverbank characterization, riverbank soil sampling for chemical characterization will be performed at up to 150 riverbank transect locations (see Figure 3-2) including a surface soil sample and a subsurface soil sample at each sampling location along the transects (e.g., top, face, and toe of bank). Riverbank soil sampling will be deferred until the SMAs have been refined and the delineation of erodible riverbank areas has been completed.

The proposed two-phased approach to riverbank characterization includes the following sequential steps:

1. Assemble available topographic and nearshore bathymetric maps and light detection and ranging maps to obtain topographic inputs for the BANCS analysis;
2. Conduct a riverbank assessment survey to characterize existing bank conditions, collect bank characteristics data sufficient to run a BANCS analysis for up to 150 transect locations to calculate bank erosion indices and near bank stress values, and identify locations where riverbank soil sampling is feasible based on material types
3. Compile riverbank assessment data and perform BANCS evaluation to calculate the degree of erodibility of the banks;
4. Identify riverbank soil sampling locations based on the results of the riverbank assessment survey, results of the BANCS evaluation, and review of existing riverbank soil data;
5. Prepare a riverbank soil sampling plan and provide to EPA for review and approval prior to initiating sampling; and
6. Conduct riverbank soil sampling.

This SRASP includes only the first phase of riverbank characterization. The first phase includes the Step 1 riverbank assessment survey and Step 2 BANCS modeling analysis. For the second phase of the work, the specific approach to Steps 3 through 6 will be documented in the Final PDI Work Plan and in the riverbank soil sampling plan that will be prepared after the riverbank assessment survey and BANCS evaluation steps are completed.

Remediation of impacted riverbanks with adjacent SMAs will become part of the preferred remedial approach presented in the Basis of Design Report for the SIB Project Area. The remediation of impacted riverbanks will be designed as an integrated part of the RD so that the connections between riverbanks and adjacent sediment remediation are accounted for and addressed in an efficient overall design strategy.

For riverbank areas with existing data and adjacent to sediment SMAs, the concentrations of ROD COCs at those areas will dictate how they are incorporated into the Basis of Design Report, as follows:

- If ROD COC concentrations are less than the CUL, no action is necessary.
- If focused COC concentrations are between the CUL and the RAL, a BANCS analysis (or equivalent) will be performed and the RD for the riverbank will be designed to resist erosion (e.g., from stormwater runoff, tidal fluctuations, propeller wash) and the riverbank will be designed to be stable.
- If focused COC concentrations exceed the RALs, a BANCS analysis (or equivalent) will be performed, as noted above.

Characterization data was available for only three shoreline properties in the SIB Upland Area, including city property with a public boat ramp at the end of SIB, and two former OUs of the Swan Island Upland Facility (Portland Shipyard [OU1] and Port property on N. Lagoon Avenue [OU3]). The historical riverbank sample results for these three sites were evaluated in Section 6 and Appendix E of the SAR (HGL, 2021b). ROD CULs for riverbank soil and in-water sediment and PCB RAL exceedances were identified. Detected concentrations of metals, PCBs, and polycyclic hydrocarbons exceeded the ROD CULs at the Portland Shipyard, and PCBs exceeded the RAL and principal threat waste threshold. Because the lateral extents of the exceedances were not defined and/or all ROD COCs were not analyzed, these conditions were identified as data gaps for the PDI, and additional characterization proposed.



## **4.0 FIELD AND SAMPLING ACTIVITIES**

The field activities described in this section flow from the data gap evaluations sampling design that has been developed based on the results of previous site investigations. Field activities include stormwater, stormwater solids, and in-line sediment trap sampling and riverbank evaluation. Refer to Table 4-1 for a summary of field activities and associated proposed samples and analyses. Worksheet #23 the QAPP summarizes analytical methods for solids and stormwater.

Field sampling activities will be conducted under the HASP and performed in accordance with the standard operating procedures (SOPs) included in Appendix A. SOPs were selected from previous Portland Harbor FSPs, and five SOP libraries maintained respectively by HGL, EPA, Pacific Groundwater Group, Mott Macdonald, and Bridgewater Group (Bridgewater). Standardized forms to be used for recording field data and documentation are included in Appendix B. Individual SOPs also include field forms to be used.

Information on chain of custody, packaging, and shipping samples is in Worksheets #26 and #27 of the UFP-QAPP. Hard copies of these documents will be provided to the project team.

### **4.1 STORMWATER AND STORMWATER SOLIDS SAMPLING**

Current stormwater and stormwater solids concentrations are needed to estimate ongoing SIB RPC concentrations and loads to the SIB sediments via inputs into the SEDCAM recontamination model. Samples will be collected from five city of Portland outfall basins (M-1, M-2, M-3, S-1, and S-2) as well as seven private outfall basins that discharge to the SIB shoreline. Equipment will be placed at elevations sufficient to minimize the potential for river water to back up to the sample location and compromise flow data quality, the integrity of the sediment traps, and collection of quality stormwater samples.

Sampling techniques for collecting stormwater samples from city conveyance systems include using an HVS system to collect and process each sample set (Gravity Marine PR2900). The system consists of a high-volume peristaltic pump or submersible pump, depending on the depth of the water in the manholes, and a series of filtration to capture the particulate phase and a resin column to capture the dissolved fraction of focused COCs. Stormwater collected via the high-volume pump will be run through an HVS system to separate stormwater and stormwater solids for separate phase (dissolved and particulate) analyses. This method is used to collect samples for analysis of hydrophobic organic compounds (dioxins/furans, PCBs, and pesticides) by ultra-low detection limit analytical methods. Analysis of stormwater samples collected via the HVS method is more likely to detect lower concentrations of focused COCs resulting in method detection limits that are at or below the CULs in ROD Errata #2 Table 17 (EPA, 2020). This method also allows for quantification of hydrophobic organic chemicals in the suspended particle and dissolved phases of the water column. EPA has approved the Gravity Marine PR2900 sampling system for the collection of representative surface water and stormwater samples in PHSS (AECOM Technical Services [AECOM] and Geosyntec, 2018; and Foth Infrastructure & Environment, LLC, 2021). Physical field measurements and a separate whole water sample will be collected in tandem with the HVS system by using a separate pump and carboy. Stormwater sampling criteria will be consistent with Appendix D of the 2005 ODEQ and EPA JSCS (ODEQ and EPA, 2005):

1. Antecedent dry period of at least 24 hours (as defined by less than 0.1 inch over the previous 24 hours).
2. Minimum predicted rainfall volume of greater than 0.2 inch per event.
3. Expected duration of storm event of at least 3 hours.

In addition to collecting stormwater solids via the HVS method, stormwater solids will be collected by (1) manual grab sampling from public manhole sumps and adjacent laterals in the conveyance systems prior to installation of sediment traps; and (2) time-integrated, in-line, sediment traps within the public conveyance system.

Because the smaller size of the private outfall conveyance systems discharging along the SIB shoreline will not accommodate all the equipment required for HVS sampling, HGL proposes to instrument conveyance systems to these outfalls with smaller auto-samplers and possibly in-line solids traps and flow meters (depending on access) and collect stormwater and solids samples during rain events meeting the ODEQ-EPA JSCS criteria, as described above. Teledyne In Situ Chemical Oxidation (ISCO)-portable autosamplers will be deployed to collect stormwater samples and flow measurements, at elevations sufficient to minimize the potential for river water to back up into the sample locations, during the same or similar JSCS storm events as the HVS samples. Manual grab samples of stormwater solids will also be collected in the private conveyance systems before deployment of the portable samplers. HGL proposes to instrument portions of the private systems with the largest drainage basins and most representative of direct discharges to SIB at the following properties shown on Figure 3-1: U.S. Coast Guard Marine Safety Unit, Port's Dredge Base, ATC Leasing Co., Barge Eagle, Inc./Swan Island Boast Company, North Basin Watumull, DTNA Corp 5 Wind Tunnel, and the Port of Portland's N. Lagoon Avenue property. The exact sampling locations in the private conveyance systems will be identified after site access agreements are negotiated and site inspections are performed.

Solids will be visually described following American Society of Testing and Materials (ASTM) D2488 (ASTM, 2017) and the Unified Soil Classification System (USCS) visual soil classification procedures.

The types of samples collected at each of the proposed sample locations are shown on Figure 3-1 and Table 3-1.

#### **4.1.1 HVS Sampling Methodology for City Outfall Basins**

Stormwater and stormwater solids will be collected during three representative storm events by pumping large quantities of stormwater from city manholes with a high-volume peristaltic or submersible pump and processing the water through an HVS system. A Pulsar Measurement Greyline Stingray 2.0 flow sensor will also be incorporated into the HVS sampling program to continuously measure flow and volume during the storm, and to collect a flow-weighted sample. This work is proposed to be conducted by the marine vessel subcontractor (Gravity Marine) with HGL oversight. High-volume water samples will be collected to quantify concentrations of targeted organic chemicals (e.g., dioxins/furans, PCBs, and pesticides) that could be present at levels too low to be detected using conventional sampling methods. This method also allows for quantification of hydrophobic organic chemicals in the suspended particle and dissolved phases of

the water column. Stormwater and stormwater solids collection will be performed in accordance with SOP A-5 Gravity Marine HVS Sampling (Appendix A).

Stormwater samples to be analyzed for ultra-low concentrations of organic compounds will be collected using a high-volume peristaltic pump with both platinum silicone tubing and extended Teflon™-lined polypropylene sample tubing lowered to the desired depth within the conveyance system. This sampling method is required to achieve the very low Table 17 CULs that are below standard method reporting limits for PCBs, dioxins/furans, and organochlorine pesticides (OCPs). Water pumped at a rate of up to 1.5 liters per minute (L/min) will be drawn through Teflon™ tubing and through each filter set. The pump rate will be managed to collect a target minimum of 200 liters (L) over each storm event that is typically 4 to 6 hours in duration. The HVS system can be paused during a single storm event if the stormwater flow temporarily subsides due to fluctuating precipitation rates. At 15-minute intervals, the rate of water pumped through the HVS will be checked to ensure that water is flowing at a constant rate using a 1-L graduated cylinder and a timer. If the pump is not delivering the correct flow rate, fine adjustments must be made until the optimum flow is achieved. If a submersible pump is required because of the water depth in the manholes, the water will be pumped through the Teflon coated tubing from the pump to an 8-gallon carboy and then the same tubing from that carboy to the HVS pump and standard peristaltic pump. In conjunction, the storm will be tracked via the National Oceanic and Atmospheric Administration National Weather Service, local weather news, and the Windy forecast at [www.windy.com](http://www.windy.com) to anticipate the length of the storm event. The Portland Harbor JSCS guidance (ODEQ and EPA, 2005) storm event criteria and selection will be utilized to ensure that stormwater runoff will be adequate for sample collection.

Within the HVS system, the stormwater will pass sequentially through a high vortex separator, a 0.45-micron glass fiber filter (142 millimeter), and then a polyurethane foam (PUF) cartridge. The high vortex separator can separate suspended sediments by forcing the water in a centrifugal fashion. Solids collected from the vortex separator and 0.45-micron glass fiber filter will be combined, homogenized, and placed into appropriate sample containers for analysis. A list of required sample containers and preservatives can be found in Worksheets #19 and #30 of the UFP-QAPP. The compounds that bind to the adsorbent PUF material will be extracted and measured on a gas chromatograph/mass spectrometer. Samples will be stored in a cooler at 0 to 6 degrees Celsius (°C) and sent to the selected laboratory for analysis.

Physical field measurements and a separate whole water sample will be collected in tandem with the HVS system sampling by connecting a second Teflon™-lined polypropylene tube to a second peristaltic pump, tubing set, and carboy with mixing chamber. This pump will have a flow-through chamber with YSI Exo multi-meter installed for continuous measurement of dissolved oxygen, pH, turbidity, and temperature. A subset of stormwater collected in the carboy will be placed into appropriate sample containers for total suspended solids (TSS) and total organic carbon analysis. Required sample containers can be found in Worksheets #19 and #30 of the UFP-QAPP. Those sample bottles and the full volume of the carboy will then be stored in a cooler at 0 to 6 °C and transported to the selected laboratory for processing and analysis. If there is a sufficient volume of stormwater solids available in the carboy, those solids will be separated by centrifuge in the laboratory and analyzed for ROD COCs, except the PCBs, OCPs, and dioxins and furans. The stormwater will also be analyzed ROD COCs, except the PCBs, OCPs, and dioxins and furans.

## **4.1.2 Calculating Dissolved, Particulate, and Total Fractions from HVS Samples**

### **4.1.2.1 Particulate Phase**

Stormwater samples will be collected using the PR2900 HVS connected to a vortex solids separation system and a 0.45-micron glass filter. The high vortex separator separates suspended sediments by forcing the water in a centrifugal fashion before exiting towards the 0.45-micron glass filter and then the PUF cartridge. The solids captured in the vortex separation system and the solids on the glass filters will be placed in one sample container, stored in a cooler at 0 to 6 °C, and shipped to the selected laboratory. The combined solids sample is referred to as the “Front Half” of the HVS system and will be analyzed by the selected laboratory to represent the total particulate phase fraction of SIB RPCs collected throughout the storm. The concentration data from the particulate fraction will be used to (1) mathematically calculate the particulate phase portion of the whole water concentration (see Section 4.1.2.1.2); and (2) mathematically calculate the particulate concentration in units of solids, for comparison to the ROD sediment CULs (see Section 4.1.2.1.3).

To support the second calculation, TSS will be measured by the selected laboratory from a sample collected from the secondary composite water sample that is collected in the carboy via a second peristaltic pump (SOP A-5 Gravity Marine HVS Sampling, Appendix A).

#### *4.1.2.1.1 Dissolved Phase*

After stormwater is pumped through the “Front Half” of the HVS system and solids are removed via the high vortex separator and 0.45-micron glass filter, the water enters the “Back Half” of the HVS system and is drawn through the PUF cartridge, which contains solid-phase extraction resins that bind dissolved forms of the compounds in question (e.g., PCBs). Once the HVS system is turned off, the sealed PUF cartridges are labeled and sent to the selected laboratory for analysis representative of the dissolved fraction of PCB congeners, dioxins/furans, and OCPs in stormwater. These analyses are listed for the aqueous matrix in Worksheets #19 and 30. Collected samples will be placed in laboratory provided glass jars and stored in a cooler at 0 to 6 °C until transport to the laboratory.

#### *4.1.2.1.2 Whole Water Concentration*

One objective of the HVS method is to quantify the PCB congeners, dioxins/furans, and OCPs concentrations in stormwater at levels that are below, or similar to, the low level CULs established for surface water in PHSS. This section describes how to convert the mass measurements provided by the laboratory into a whole water concentration that can be compared to ROD surface water CULs.

The laboratory will report the total mass of the particulate (i.e., “Front Half”) and dissolved phase (i.e., “Back Half” driver COCs) in laboratory reports in units of picograms (pg). Once that data is validated, the data will be used to mathematically calculate whole water concentrations using the following equation.

$$\frac{\text{Particulate Phase (pg)}}{\text{Sample Volume (L)}} + \frac{\text{Dissolved Phase (pg)}}{\text{Sample Volume (L)}} = \text{RPC Concentration (pg/L)}$$

where:

- Particulate phase is the analytical sample consisting of the solids from the vortex and glass microfiber filters (pg/sample);
- Dissolved phase is the dissolved fraction adsorbed to the PUF cartridge (pg/sample); and
- Sample volume is the total amount of water passed through the PR2900 during sample collection (L).

As noted in SOP A-5 Gravity Marine HVS Sampling (Appendix A), a minimum target volume of approximately 200 L of water will be pumped through the system. Flow rates will be low (approximately 1.5 L/min) to allow for adsorption of dissolved-phase COCs to the PUF cartridge and to ensure that equal representation from the storm is reflected in the combined analytical results. Each storm and associated location will have different total volumes pumped, which will be provided by the subcontractor and used by HGL in these calculations.

#### 4.1.2.1.3 Particulate Phase Concentration

A second objective of the HVS method is to capture enough stormwater solids to quantify the concentration and loading rate of those solids discharging from the city outfalls to the Willamette River and evaluate the risk of ongoing recontamination to sediment near the outfalls. This section describes how the particulate phase mass provided by the selected laboratory (in pg) and the TSS measurement provided by the other selected laboratory (in milligrams per liter [mg/L]) will be used to calculate the driver COC concentrations in stormwater solids, which can then be compared to the PHSS CULs and RALs.

Once the laboratory data is validated, the data will be used to mathematically calculate whole water concentrations using the following equation.

$$\frac{\frac{\text{Particulate Phase (pg)}}{\text{Sample Volume (L)}}}{\text{TSS (mg/L)}} = \text{RPC Concentration (micrograms per liter)}$$

where:

- Particulate phase is the analytical sample consisting of the solids from the vortex and glass microfiber filters (pg/sample);
- Sample volume is the total amount of water passed through the PR2900 during sample collection (L);
- TSS is the concentrations (in mg/L) measured from an aliquot of water collected from the carboy sample; and
- The resultant RPC concentration is in pg to proton masses. The proton mass is the total particulate phase mass collected from the high vortex sampling during HVS for

stormwater and calculated by the analytical laboratory. The proton mass of particles =  $1.67 \times 10^{-12}$  pg, where 1 kilogram =  $1.0 \times 10^{15}$  pg and  $1.0 \times 10^9$  micrograms, which is the same as microgram per kilogram, a more typical measurement of sediment concentrations.

#### **4.1.3 Automatic Stormwater Sampling Methodology for Private Outfalls**

Autosamplers (e.g., Teledyne ISCO 6712C portable samplers with flow meters) will be used to collect grab samples from small private conveyance systems to assess whether COCs in stormwater are controlled prior to the RD. The samplers will be automatically programmed to collect samples to evaluate COC concentrations discharging to SIB and the need for source control measures. Proposed deployment locations were selected based on the location of discharges relative to SMAs, ROD CUL/RAL exceedances, and/or lack of data adjacent to SMAs.

The automatic samplers are proposed for the private outfalls because the outfalls are too small and convey too little flow to support the use of the HVS sampling approach. Compared to a grab sample, the HVS sampling approach provides a superior characterization of chemical loading rates by accounting for the variability of COC concentrations over the range of variable discharge rates. HVS sampling also provides a means of determining COC loading rates when COC concentrations in stormwater are low. Automated samplers do not provide the same benefits as the HVS methodology, but they are superior to grab samples because they provide flow measurements that are correlated with sample collection timing such that samples are obtained at times when chemical concentrations would be higher.

During the three storm events when HVS samples are collected or similar events meeting ODEQ-EPA JSCS criteria (as described above), discrete stormwater samples will be collected from seven private outfall basin locations using automatic samplers to provide a “snapshot” of RPC concentrations discharging to the SIB during rain events meeting the ODEQ-EPA JSCS criteria similar to the HVS samples collected in city outfall basins, although during shorter sampling duration events. Grab samples will be collected during storm periods expected to have higher chemical concentrations (e.g., rising limb of stormwater flow hydrograph), to increase the likelihood of detecting RPCs if discharging in stormwater.

#### **4.1.4 Manual Grab Stormwater Solids Sampling Methodology**

Manual grabs to collect stormwater solids from manhole sumps and/or adjacent conveyance systems will be conducted in a single sampling event. Sampling will be performed in accordance with the Storm Drain Sediment Sampling SOP A-4 Storm Drain Sampling (Appendix A).

Sample collection from manhole sumps and/or adjacent conveyance systems will incorporate material representative of the total depth of accumulated solids. The stormwater solids sampling subcontractor will select sampling equipment that is suitable for site conditions. Sampling equipment will be decontaminated prior to use. Section 4.9 of the FSP provides more detailed information on decontamination procedures.

Standing water in the manhole sump, if present, may be pumped off to simplify solids sample collection. Firm solids above the water line are most easily collected using simple soil sampling tools such as a stainless-steel spoon, scoop, or trowel. If necessary, the spoon, scoop, or trowel

may be attached to an extension pole to reach the bottom of the manhole and/or adjacent conveyance systems, provided a representative sample can be recovered intact. Stainless steel bucket augers (hand augers) typically have long handles (>4 feet [ft]) and can also be used to collect solids from deeper junctions. While it may be possible to sample solids in manhole sumps without confined space entry, manholes without sumps or without visible solids may require confined space entry to determine if sufficient solids have accumulated in the adjacent conveyance systems for collection. If no or limited solids are present, that will be noted in the field documentation and an alternative nearby manhole may be selected for evaluation based on consultation with the HGL project manager and technical leader.

Clean and appropriate sampling equipment will be advanced into the manhole sump, where present, to collect solids in each corner (or, if round, each compass point) and the center of the junction. Solids will be visually described following ASTM D2488 (ASTM, 2017) and USCS visual soil classification procedures. Collected solids will be placed in laboratory provided glass jars and stored in a cooler at 0 to 6 °C until transport to the laboratory. The entire grab sample will be analyzed.

#### **4.1.5 In-Line Sediment Trap and Flow Meter Installation and Sampling Methodology**

If access to the city conveyance system is granted by the end of September 2021, in-line sediment traps will be installed in select locations in the city's conveyance system during the fourth quarter 2021 (October), before the wet season begins. Sample bottles will be removed and replaced at the end of January, April, and June 2022 for compositing and analyses representing wet season accumulation. Bottles will be deployed in June 2022 until October 2022 during the dry season, and analyses will represent dry weather accumulation.

The locations are shown on Figure 3-1. Sampling of stormwater solids via in-line sediment traps is proposed to be conducted by an HGL subcontractor. Sampling will be performed in accordance with In-Line Sediment Trap SOP A-6 In-Line Sediment Trap (Appendix A).

In-line sediment traps will consist of custom stainless-steel brackets holding 1-L, high-density polyethylene sample bottles. At each designated sampling location, in-line sediment traps will be installed at the bottom of the conveyance system. In-line sediment traps will be firmly secured to the conveyance system to prevent unintended transport of the equipment. It is anticipated that confined space entry procedures will be required to install the sediment traps. These procedures will be outlined in the HASP. In-line sediment trap brackets and related equipment will be decontaminated prior to installation and new clean laboratory supplied 1-L bottles will be utilized within the brackets.

When the sample bottles are collected and submitted for archival and subsequent analysis after the first targeted deployment period, they will be replaced by clean and decontaminated bottles. Section 4.9 of the FSP provides more detailed information on decontamination procedures.

A Pulsar Measurement Stingray 2.0 velocity – depth probe, deployed during in-line sediment trap deployment periods and during city outfall basin HVS sampling events, will be mounted on stainless-steel plates and securely fastened to the bottom of the stormwater pipe using small (0.25-inch) stainless-steel anchor bolts and nuts. The cable from the flowmeter module to the probe will

be fastened to the pipe using the same hardware and protected from high flows. If necessary, the cable will be shielded using a 1-inch flexible electric conduit. The module will be positioned near the top of the invert, directly beneath the manhole cover, to allow easy access for downloads and inspections. The flow module is fitted with cable strap locations, which will be used to tie the module to the top ladder rung.

At the end of each targeted deployment period, the four, 1-L sample bottles will be capped and stored in a cooler at 0 to 6 °C until transport to the laboratory and archival pending compositing and analyses. The entire sediment trap solids samples will be analyzed. At the end of the final deployment period, in-line sediment traps and equipment will be removed from the stormwater systems.

#### **4.1.6 Contingency Plans**

##### **4.1.6.1 HVS System Sampling**

The HVS system will target the optimal 200-L total stormwater sample volume collected at the average 1.5 L/min pump rate. If the storm flow volume and/or flow period does not allow for attainment of this sample volume and/or flow rate, but still meets the JSCS criteria for a qualifying storm, the sample will still be collected at an adjusted flow rate if the storm allows. The effect of pumping less than the optimal 200 L minimum through the HVS system will affect the achievable laboratory detection limit, although even with limited volume the detection limits performed on the HVS system samples are well below the levels achieved via conventional laboratory analyses.

##### **4.1.6.2 Manual Grab Solids Sampling**

Manual stormwater solids grab samples will be collected at time of entry if a minimum of 226.8 grams (8 ounces) of solids are present. If less than 8 ounces of solids are present, then the manual grab sample location shall be abandoned and alternative locations will be inspected, and one of the alternative locations will be sampled if at least 8 ounces of sediment is present. Alternative locations without at least 8 ounces of sediment present will not be sampled.

##### **4.1.6.3 In-Line Sediment Trap Sampling**

Each location includes four sample bottles, which increases the anticipated mass of collected stormwater solids compared to less bottles. If sample volume is limited, analysis of the PHSS-focused COCs (PCBs, OCPs, and dioxins/furans) will be prioritized over the remaining ROD COCs.

##### **4.1.6.4 General**

In instances where ROD COCs and conventional parameters are targeted for analysis, but insufficient stormwater solids or stormwater volume exists to run that full analysis, then PCBs, OCPs, and dioxins/furans will be prioritized over other analytes. In that instance, a list of analytical priorities for that specific sample location will be provided to the laboratory by the sampling and analysis coordinator, through consultation with the HGL project manager.



## **4.2 RIVERBANK FIELD CHARACTERIZATION – PHASE 1 ASSESSMENT**

This section describes the riverbank assessment survey procedures for the first phase of riverbank characterization. The SIB riverbanks will be accessed by field staff via upland areas or by boat where upland access is restricted. Most areas are accessible through the shoreline facility properties, and field staff will follow the sign-in/sign-out protocols for the respective facilities. A total of 150 transects (1 per every 100-lineal-ft of riverbank assuming 15,000-lineal ft of bank) are targeted for visual inspection during the first phase riverbank assessment survey. Proposed transect locations are shown on Figure 3-2.

The riverbank assessment survey will document shoreline conditions, delineate areas of potentially erodible riverbank materials, and locate areas of geotechnical movement (slope rotational failure, settlement). The riverbank assessment survey will include the entire riverbank within the SIB Project Area. Survey results will be used to complete a bank stability analysis using the BANCS model including BEHI and near bank stress determinations. The riverbank assessment survey will include visually inspecting and photo-documenting the riverbank and material types to determine input parameters for the BANCS evaluation. The riverbank assessment survey will record the following observations at each survey transect:

- Bank armoring and stabilization measures - presence, nature, extent, and qualitative condition.
- Shoreline structure on the bank – presence, description, and qualitative condition.
- Bank vegetation – presence and description.
- Bank composition – document visually determined soil attributes (e.g., soil textures, colors) for exposed surface soils.
- Evidence of bank erosion – consider erosion caused by runoff and overland flow, waves, and currents.
- Bank geometry – slope, height, and shape.
- Toe condition – describe the transition from bank soils to submerged sediments.

After the proposed first phase riverbank assessment survey, HGL will prepare a riverbank soil sampling plan as an addendum that specifies data quality objectives and proposed sampling locations. The first phase riverbank assessment would be performed when water levels are at their lowest in SIB (anticipated to occur from fourth quarter 2021 through first quarter 2022).

The proposed two-phased approach to characterization will develop data required for determining which riverbank areas need further detailed erodibility/stability assessments by coastal and geotechnical engineers during the PDI. This data will also be used to delineate riverbank areas susceptible to erosion for future use in the RD. Coordinates of erodible and non-erodible areas will be mapped using hand-held GPS, backed up with field notes on tablets.

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## 5.0 REFERENCES

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## **TABLES**

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**Table 2-1**  
**Summary of Data Gaps and Proposed Data Collection**  
**Stormwater and Riverbank Assessment and Sampling Plan; Swan Island Basin Project Area, Portland, Oregon**

<b>Data/Analysis Type</b>	<b>Data Gaps</b>	<b>Proposed Data Collection</b>
Riverbank Characterization	Riverbanks within Swan Island Basin Project Area not adequately characterized to assess source control sufficiency and inform stabilization as part of Remedial Design.	<ul style="list-style-type: none"><li>• Visual survey of physical bank conditions to evaluate erosion potential and delineate areas of potentially erodible soil and other materials.</li><li>• Coordinate with geotechnical sampling program to evaluate geotechnical failure potential and characterize soil conditions (e.g., grain size, soil erodibility).</li></ul>
Stormwater Discharge	Lack of adequate data on ROD Table 17 contaminants of concern (COCs) loading from municipal and private outfalls to determine source control sufficiency and complete the Sufficiency Assessment Report.	<ul style="list-style-type: none"><li>• Inventory of the current status of discharges from private outfalls that discharge to areas with ROD COC exceedances in sediments.</li><li>• Conduct high-volume, time-weighted sampling to support ROD COC load calculations at five municipal stormwater outfalls.</li><li>• Collect stormwater grab samples and stormwater solids samples using in-line traps at 11 locations in the municipal stormwater system.</li><li>• Conduct reconnaissance of seven private stormwater conveyance systems to determine if sampling is possible.</li></ul>

Table 3-1  
Summary of Stormwater System Sampling Activities Locations  
Stormwater and Riverbank Assessment and Sampling Plan; Swan Island Basin Project Area, Portland, Oregon

Basin ID	Sample Location		Sample Type		Location Info				Property	Alternate sample location			
	Manhole ID	Outfall ID	HVS	Other Sample Type	Vault Depth (Portland Maps ft)	Pipe Diameter (Portland Maps inches)	PipeInvert Elevation (COP)	Pipe Invert Elevation (MBDC)		Manhole ID	Vault Depth (Portland Maps ft)	Pipe Elevation (COP)	Pipe Elevation (MBDC)
City of Portland Stormwater Conveyance System													
M-1	AAM107	-	YES	-	26.3	60	9.5	6.57	COP BES - 6380 N Ensign St.	AAM104	25	13.1	10.17
	AAM104	-	No	ILS MSG	25	inlets 36, 27 & 54 outlet 60	13.1	10.17	COP BES - 6540 N Basin Ave.	AAM105	20.6	13.6	10.67
										AAJ935	16.5	12.6	9.67
										AAJ810	19.5	13.1	10.17
M-2	AAM169	-	YES	ILS MSG	20.6	inlets 27, 60 & 27 outlet 60	10.57	7.64	COP BES - 6010 N Basin Ave.	AAM170 (Preferable)	20.9	10.93	8
				ILS MSG						AAM192	18	12.92	9.99
										AAM165	18	20.6	17.67
M-3	AAQ003	-	YES	ILS MSG	29.5	inlets 21, 60 outlet 60	3.92	0.99	COP BES - 5500 N Basin Ave.	AAQ004 (Preferable)	24.5	6.03	3.1
	AAQ011	-	No	MSG	4.6	15	25.8	22.87	COP BES - 3210 N. Webster St.	AAQ008	11.5	20.04	17.11
S-1	AAM131	-	YES	ILS MSG	21.7	inlets 27, 18 outlet 36	14.14	11.21	COP BES - 5700 N Lagoon Ave.	NA			
S-2	AAP957	-	YES	ILS MSG	22.1	inlets 30, 21 outlet 36	13.5	10.57	COP BES - 5050 N Lagoon Ave.	NA			
Private Conveyance System													
USCG Marine Safety Unit (WR-198, WR-199, WR-200 or WR-201)			SWG	VIS SWG/MSG	TBD								
Port of Portland Dredge Base / UPS (WR-70)			SWG	VIS SWG/MSG	TBD								
ATC Leasing / Auto Truck Transport (WR-69, WR-71 or WR-289)			SWG	VIS SWG/MSG	TBD								
Barge Eagle (WR-68, WR-185, or WR-186)			SWG	VIS SWG/MSG	TBD								
NW Paperbox Manufacturing (WR-16)			SWG	VIS SWG/MSG	TBD								
Daimler Trucks North America WInd Tunnel / Corn 5 (WR-429)			SWG	VIS SWG/MSG	TBD								
Port of Portland Lagoon Avenue Property (WR-30, WR-31, WR-32, WR-33, WR-34, or WR-35)			SWG	VIS SWG/MSG	TBD								

Notes:

ft = feet  
BES = Bureau of Environmental Services  
COP = City of Portland  
HVS = high-volume, time-weighted sampling  
ID = identification  
ILS = in-line solids (confined space entry)  
MBDC = Morrison Bridge Datum correction  
MSG = manual solids grab (confined space entry)  
NA = not applicable  
SWG = stormwater grab (possible confined space entry)  
TBD = to be determined  
USCG = U.S. Coast Guard  
VIS = visual outfall inspection

Current River Level (MBDC): [https://nwis.waterdata.usgs.gov/usa/nwis/uv/?cb\\_00065=on&format=gif\\_stats&site\\_no=14211720&period=&begin\\_date=2021-01-26&end\\_date=2021-02-02](https://nwis.waterdata.usgs.gov/usa/nwis/uv/?cb_00065=on&format=gif_stats&site_no=14211720&period=&begin_date=2021-01-26&end_date=2021-02-02)  
<https://waterdata.usgs.gov/monitoring-location/14211720/#parameterCode=00065&period=P7D&compare=true>  
Projected River Level (MBDC): <https://water.weather.gov/ahps2/hydrograph.php?gage=prto3&wfo=pqr>



**Table 4-1**  
**Summary of Sample Activities, Numbers, and Analyses**  
**Stormwater and Riverbank Assessment and Sampling Plan, Swan Island Basin Project Area, Portland, Oregon**

Sample Type	Number of Stations	Number of Samples	Analyses
Stormwater and Stormwater Solids	COP Stormwater Outfall Basin Stations: 5 (3 Events)	HVS Stormwater: 18 (including 3 equipment rinsate blanks)	Table 17 COCs
	COP Stormwater Outfall Basin HVS Stations: 5 (3 Events)	HVS Solids: 15	Table 17 COCs
	COP Stormwater Outfall Basin Stations: 11	In-Line Solids: 33	Table 17 COCs
	City and Private Systems: 13	Manual Grab Samples: 18	Table 17 COCs

**Notes:**

Surface samples will target 0- to 30-centimeter depth

Study Area = Swan Island Basin Study Area between river miles 8.1 and 9.2.

See Table 2.2 of FSP for details on updated ROD Table 21 focused COCs and ROD Table 17 COCs.

COCs = ROD Table 17 contaminant of concern

COP = City of Portland

HVS = high-volume, time-weighted sampling

ROD = Record of Decision for Portland Harbor Superfund Site

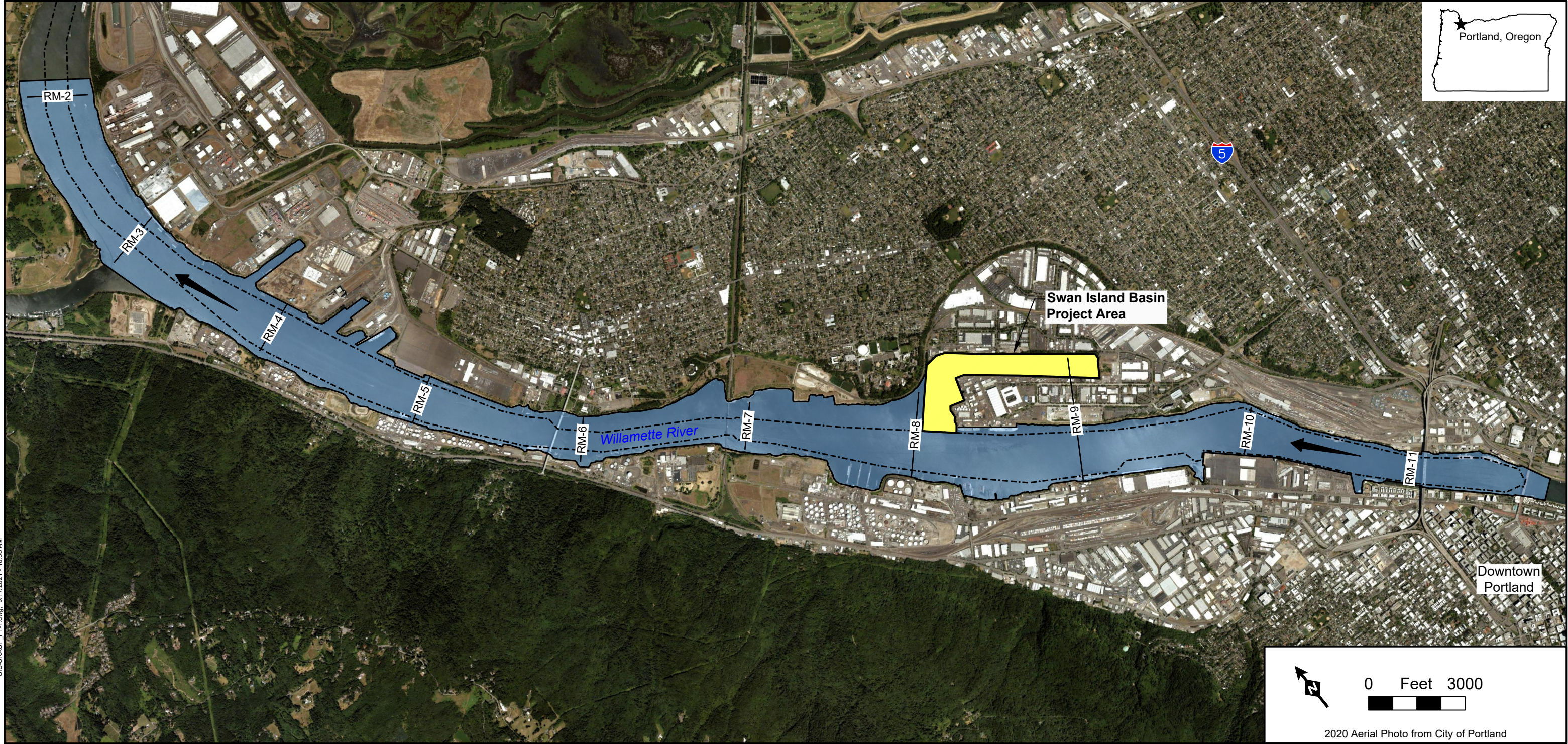
SIB = Swan Island Basin

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## FIGURES

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- Navigation Channel
- River Flow Direction
- Swan Island Basin Project Area
- Portland Harbor Superfund Site Boundary (River Mile 1.9 to 11.8)

Notes:  
NOAA - National Oceanic and Atmospheric Administration  
RM - river mile  
SIB - Swan Island Basin

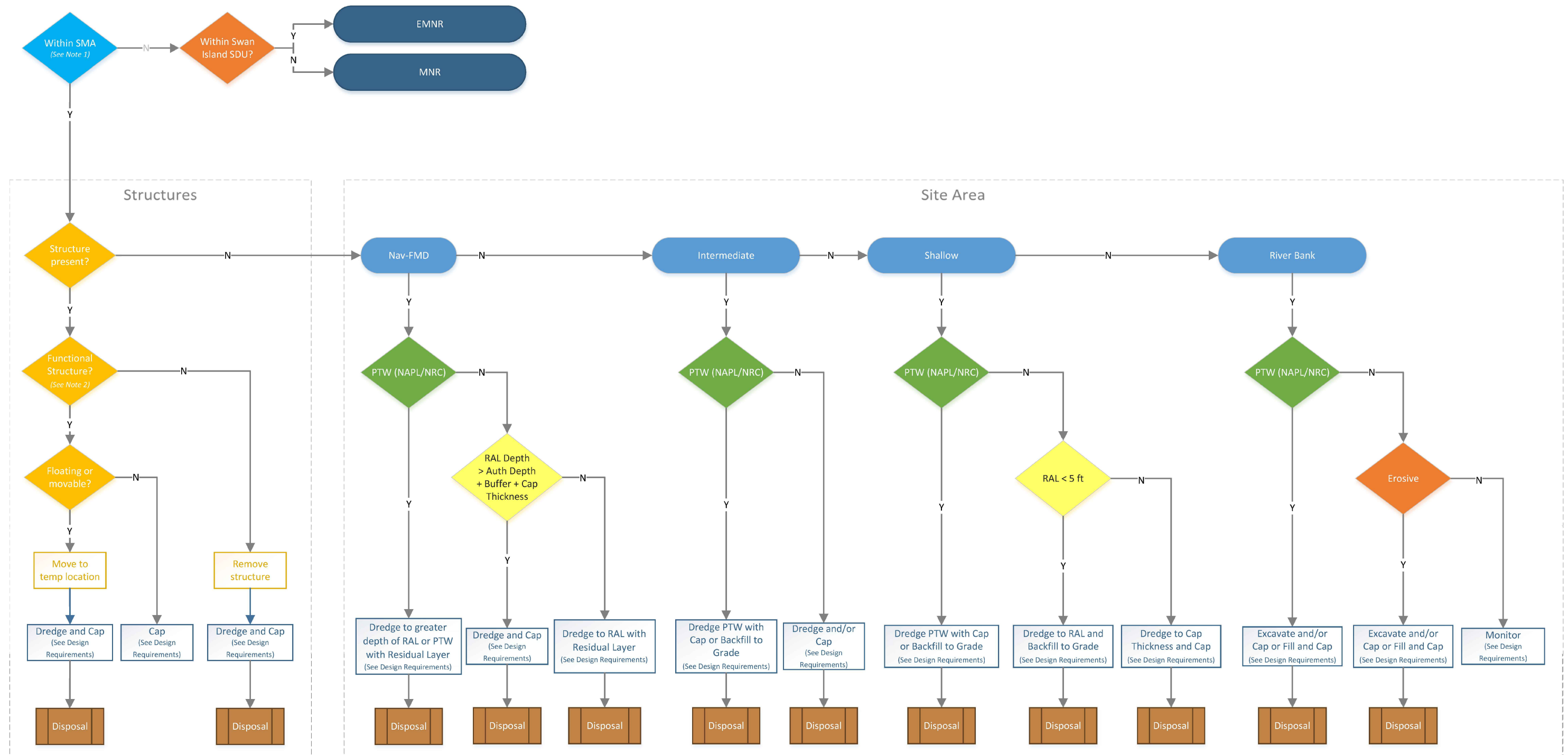
Source:  
NOAA, 2016. Booklet Chart, Willamette River – Swan Island Basin, NOAA Chart 18527 at URL:  
[https://www.charts.noaa.gov/BookletChart/18527\\_BookletChart.pdf](https://www.charts.noaa.gov/BookletChart/18527_BookletChart.pdf)  
- Navigation Channel

Figure 1-1  
SIB Project Area Location Map

Prepared on 9/17/2021  
Stormwater and Riverbank  
Assessment and Sampling Plan  
Swan Island Basin



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Notes:  
EMNR - enhanced monitored natural recovery  
EPA - U.S. Environmental Protection Agency  
MNR - monitored natural recovery  
NAPL - non-aqueous phase liquid  
Nav-FMD - Navigation Channel -  
Future Maintenance Dredge Area  
NRC - not reliably contained  
PHSS - Portland Harbor Superfund Site  
PTW - principal threat waste  
RAL - Remedial Action Level  
ROD - Record of Decision  
SDU - Sediment Decision Unit  
SMA - Sediment Management Area

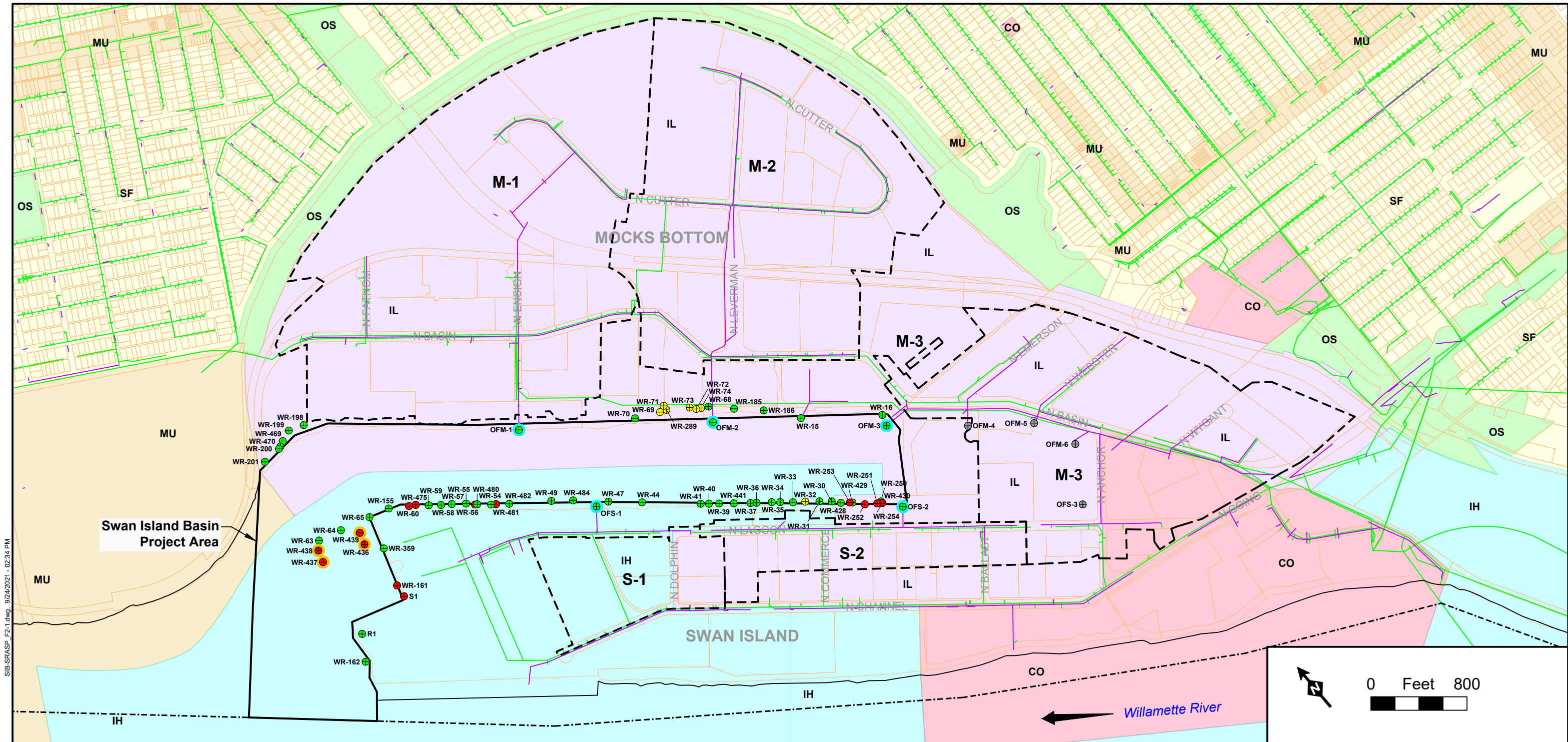
(1) Contamination is defined in three dimensions.  
(2) Currently operating or used to stabilize bank. Service life > 50 years.

Source:  
PHSS ROD, EPA, January 2017, Figure 28

## Figure 1-2 Technology Application Decision Tree

Prepared on 9/15/2021

Stormwater and Riverbank  
Assessment and Sampling Plan  
Swan Island Basin



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--- Drainage Basin  
 - - - - - Navigation Channel  
 --- Tax Lot Boundary  
 ← River Flow Direction

**Zoning**

<b>IH</b> Heavy Industrial	<b>MU</b> Mixed Use Residential
<b>IL</b> Light Industrial	<b>SF</b> Single Family Residential
<b>CO</b> Commercial	<b>OS</b> Parks and Open Space

**Collection Lines**

— Stormwater Line    — Sewer Line

**Outfalls**

● Active    ● Inactive    ⊕ Abandoned    ⊕ Unknown

● Active - City of Portland Municipal Outfalls (M-1, M-2, M-3, S-1 and S-2)

● Inactive - Former Non-Contact Cooling Water Discharge Points (WR-436 through WR-439)

**Notes:**  
 NOAA - National Oceanic and Atmospheric Administration  
 SIB - Swan Island Basin

**Sources:**

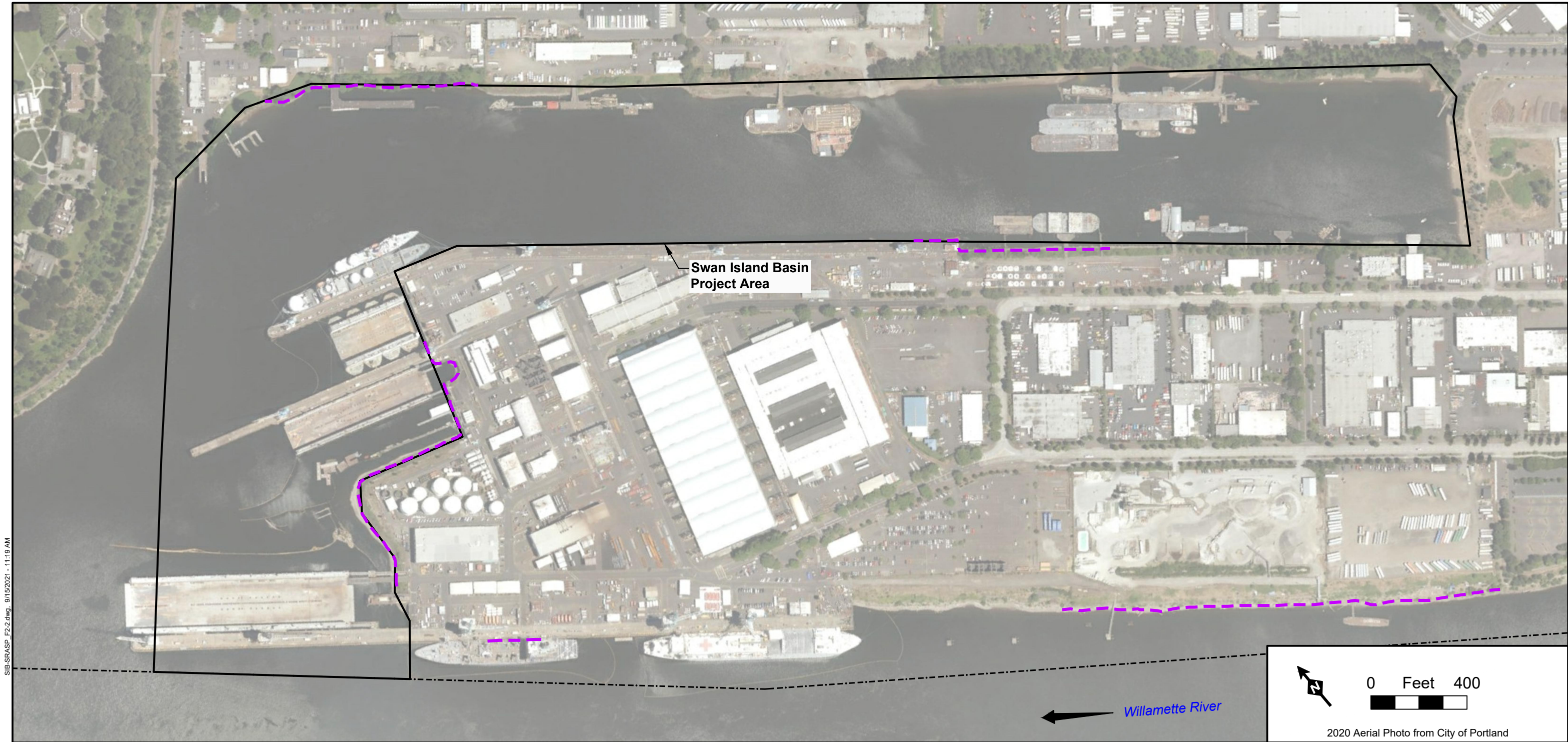
- (1) City of Portland Bureau of Environmental Services
  - Outfalls
  - Drainage Basins (except S-1)
  - Collection Lines
- (2) Vigor Stormwater Program Staff
  - Portland Shipyard Outfalls (June 21, 2021)
  - Drainage Basin S-1 (September 2021)
- (3) Oregon Metro Regional Land Information System
  - Zoning (January 26, 2021)
  - Tax Lots (July 23, 2020)
- (4) NOAA, 2016. Booklet Chart, Willamette River – Swan Island Basin, NOAA Chart 18527 at URL: [https://www.charts.noaa.gov/BookletChart/18527\\_BookletChart.pdf](https://www.charts.noaa.gov/BookletChart/18527_BookletChart.pdf)
  - Navigation Channel

**Figure 2-1**  
**SIB Upland Area**  
**Zoning and Drainage Basins**

Prepared on 9/24/2021  
 Stormwater and Riverbank  
 Assessment and Sampling Plan  
 Swan Island Basin

PACIFIC groundwater GROUP  
**HGL**  
 HydroGeologic, Inc.  
 MOTT MACDONALD  
 BRIDGEWATER GROUP





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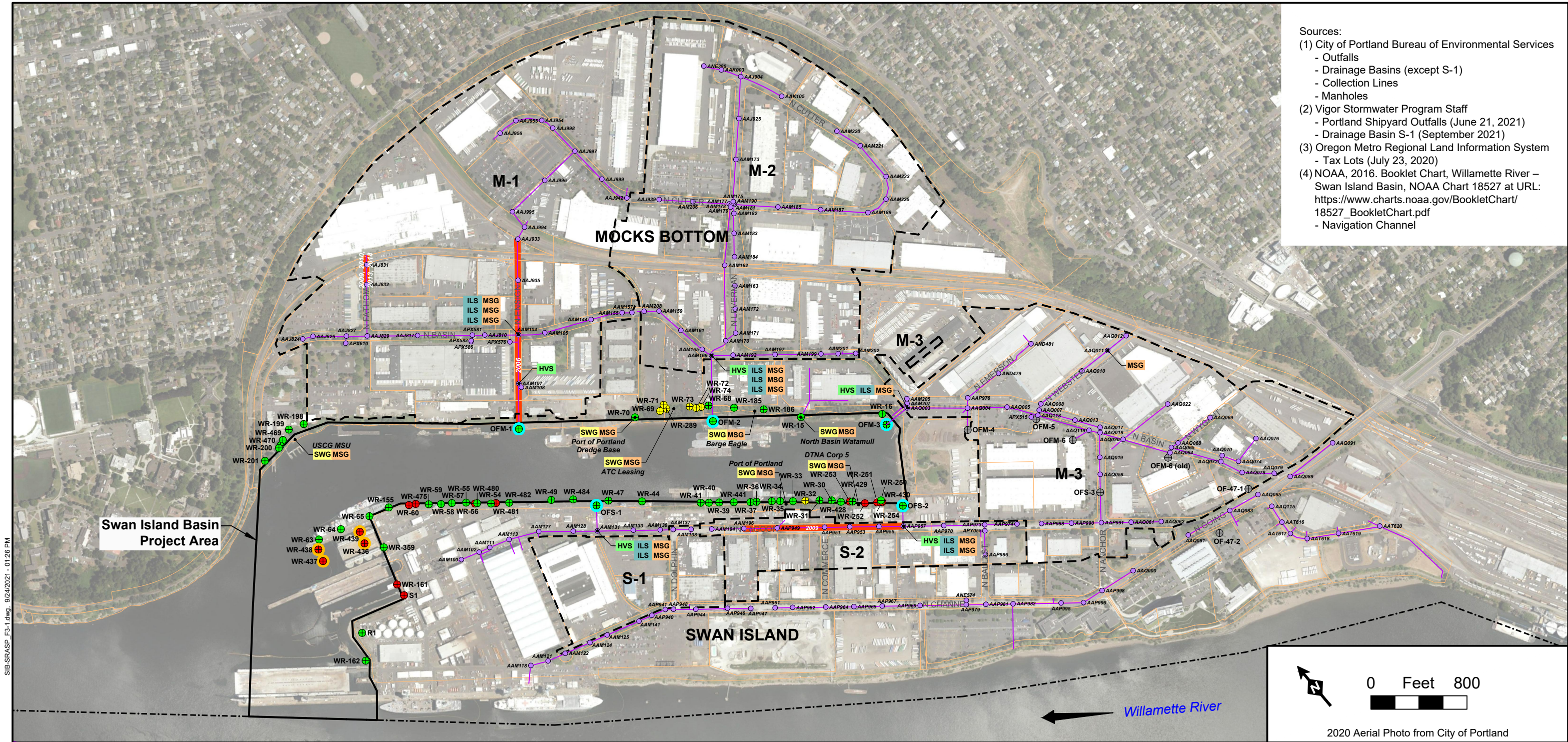
- Known Contaminated Riverbanks
- - - - - Navigation Channel
- ← River Flow Direction

**Notes:**  
 EPA - U.S. Environmental Protection Agency  
 NOAA - National Oceanic and Atmospheric Administration  
 PHSS - Portland Harbor Superfund Site  
 ROD - Record of Decision

**Sources:**  
 (1) Adapted from: Figure 31d from EPA, 2017. ROD, PHSS, Portland, Oregon.  
 - Known Contaminated Riverbanks  
 (2) NOAA, 2016. Booklet Chart, Willamette River – Swan Island Basin, NOAA Chart 18527 at URL:  
[https://www.charts.noaa.gov/BookletChart/18527\\_BookletChart.pdf](https://www.charts.noaa.gov/BookletChart/18527_BookletChart.pdf)  
 - Navigation Channel

**Figure 2-2**  
**Known Contaminated Riverbanks**





Sources:

- (1) City of Portland Bureau of Environmental Services
  - Outfalls
  - Drainage Basins (except S-1)
  - Collection Lines
  - Manholes
- (2) Vigor Stormwater Program Staff
  - Portland Shipyard Outfalls (June 21, 2021)
  - Drainage Basin S-1 (September 2021)
- (3) Oregon Metro Regional Land Information System
  - Tax Lots (July 23, 2020)
- (4) NOAA, 2016. Booklet Chart, Willamette River – Swan Island Basin, NOAA Chart 18527 at URL: [https://www.charts.noaa.gov/BookletChart/18527\\_BookletChart.pdf](https://www.charts.noaa.gov/BookletChart/18527_BookletChart.pdf)
  - Navigation Channel

Notes:

EPA - U.S. Environmental Protection Agency  
HVS - high-volume, time-weighted sampling  
NOAA - National Oceanic and Atmospheric Administration  
RI - Remedial Investigation  
FS - Feasibility Study  
ROD - Record of Decision

- (1) The HVS methodology includes pumping stormwater at a consistent rate over the duration of the storm and running high volumes of water through the HVS system to distinguish between the dissolved and solids fractions and obtain ROD cleanup levels for focused contaminants of concern.
- (2) The in-line sediment trap design is similar to that utilized in the EPA-approved Round 3A Stormwater Field Sampling Plan, Portland Harbor RI/FS (LWG, 2007). If possible, one trap will be installed in each lateral.

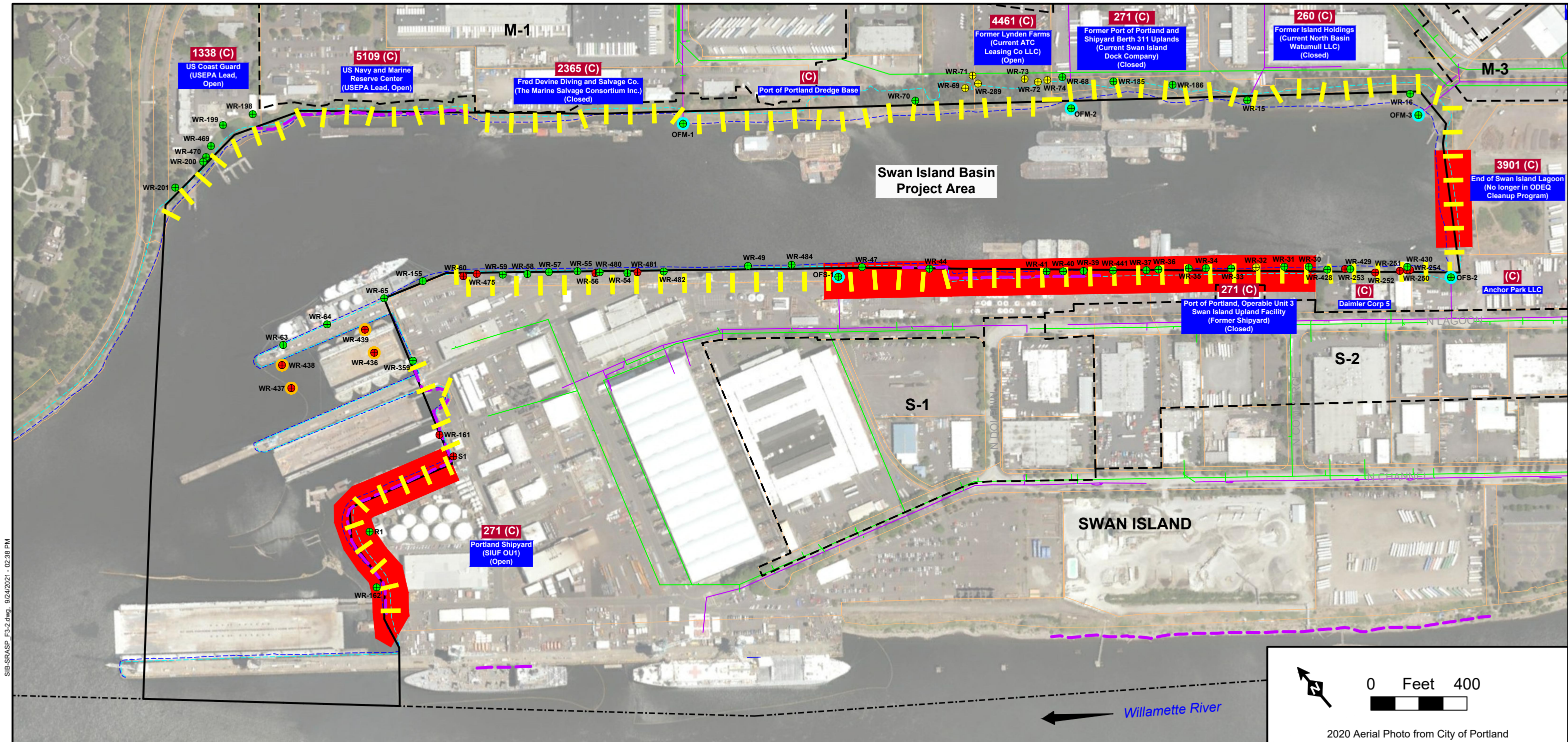
- (3) Manual stormwater solid grab samples will be collected at time of manhole entry if a minimum of 8-ounces of solids are present in manhole/ lateral. If less than 8-ounces of solids are present, then the manual grab sample locations shall be abandoned and alternative upstream locations will be inspected and selected.
- (4) Stormwater grab samples will be collected using ISCO auto-samplers.
- (5) Where visual outfall inspections reveal the presence of solids, a single composite manual grab sample will be collected from all outfalls on the property.

Figure 3-1  
Proposed Stormwater  
Sampling Locations

Prepared on 9/24/2021

Stormwater and Riverbank  
Assessment and Sampling Plan  
Swan Island Basin





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- Drainage Basin    - - - - - Navigation Channel    --- Tax Lot Boundary  
 ← River Flow Direction
- Riverbank Investigations**
- Riverbank Sampling Transect (proposed)
  - Known Contaminated Riverbanks
  - Previous Riverbank Investigation Areas Exceeding Cleanup Levels
- Collection Lines**
- Stormwater Line
  - Sewer Line
- Outfalls**
- Active
  - Inactive
  - Unknown
  - ⊕ Active - City of Portland Municipal Outfalls (M-1, M-2, M-3, S-1 and S-2)
  - ⊕ Inactive - Former Non-Contact Cooling Water Discharge Points (WR-436 through WR-439)

**Notes:**  
 EPA - U.S. Environmental Protection Agency  
 ODEQ - Oregon Department of Environmental Quality  
 OU - Operable Unit  
 NAVD88 - North American Vertical Datum of 1988  
 NOAA - National Oceanic and Atmospheric Administration  
 PHSS - Portland Harbor Superfund Site  
 ROD - Record of Decision  
 SIUF - Swan Island Upland Facility

**Sources:**  
 (1) PHSS ROD, EPA, January 2017  
     - Known Contaminated Riverbanks  
 (2) Ash Creek Associates, 2012a and b  
     - Previous Riverbank Investigation Areas Exceeding Cleanup Levels (Shipyard)  
 (3) Groundwater Solutions Inc., 2013  
     - Previous Riverbank Investigation Areas Exceeding Cleanup Levels (End of Lagoon)

- (4) City of Portland Bureau of Environmental Services  
 - Outfalls  
 - Drainage Basins (except S-1)  
 - Collection Lines
- (5) Vigor Stormwater Program Staff  
 - Portland Shipyard Outfalls (June 21, 2021)  
 - Drainage Basin S-1 (September 2021)
- (6) NOAA, 2016. Booklet Chart, Willamette River – Swan Island Basin, NOAA Chart 18527 at URL: [https://www.charts.noaa.gov/BookletChart/18527\\_BookletChart.pdf](https://www.charts.noaa.gov/BookletChart/18527_BookletChart.pdf)  
 - Navigation Channel
- (7) Oregon Metro Regional Land Information System  
 - Tax Lots (July 23, 2020)
- (8) EPA Riverbank Guidance, Figure 3 RB Conceptual Diagrams, December 2019  
 - Mean Low Water  
 - Ordinary High Water

**Figure 3-2**  
**Proposed Riverbank**  
**Characterization Transects**

Prepared on 9/24/2021

Stormwater and Riverbank  
 Assessment and Sampling Plan  
 Swan Island Basin



## **APPENDICES**

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## **APPENDIX A**

### **STANDARD OPERATING PROCEDURES**


- HGL SOP 300.04 Field Logbook Use and Maintenance
- HGL SOP 403.02 Hand-Operated Auger Soil Sampling
- HGL SOP 403.03 Soil or Sediment Sample Composting
- HGL SOP 403.04 Direct-Push Technology Soil Sampling
- HGL SOP 403.06 Surface and Shallow Depth Soil Sampling
- HGL SOP 403.07 Borehole Logging
- HGL SOP 403.08 Sediment Sampling
- HGL SOP 411.02 Sampling Equipment Cleaning and Decontamination
- HGL SOP 411.03 Subsurface Utility Avoidance
- Pacific Groundwater Group SOP A-1 Hydrocarbon Field Screening (Integral, 2004)
- Pacific Groundwater Group SOP A-2 PID Screening and Calibration Procedures (AECOM and Geosyntec, 2018a)
- Pacific Groundwater Group SOP A-3 Sampling Photography
- EPA SOP A-4 Storm Drain Sampling
- Gravity SOP A-5 Gravity Marine HVS Sampling
- FMC SOP A-6 In-Line Sediment Trap
- Pacific Groundwater Group SOP A-7 Horizontal and Vertical Control

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**SOP 300.04, SIB Project Area, PHSS**  
**(Source: Field Logbook Use and Maintenance)**

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	<b>STANDARD OPERATING PROCEDURE</b>	
	Approved by: <b>Dick, Jeff</b>	Digitally signed by Dick, Jeff Date: 2019.11.24 13:42:00 -05'00' Corporate Quality Manager
<b>Field Logbook Use and Maintenance</b>	<b>SOP No.: 300.04 (formerly 4.07)</b>	
	<b>SOP Category: QA/QC</b>	
	<b>Revision No.: 3</b>	
	<b>Revision Date: November 20, 2019</b>	
	<b>Review Date: November 2021</b>	

## 1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the methods for use and maintenance of field logbooks. This procedure outlines methods, lists examples for proper data entry into a field logbook, and provides the standardized HGL format. Field logbooks provide a means for recording observations and activities at a site and are intended to provide sufficient data and observations to reconstruct field events. Logbooks are a primary source of evidence referenced during legal proceedings. The overall requirement is to document field activities without having to rely on memory.

## 2.0 SCOPE AND APPLICATIONS

This procedure provides guidance for logbook use and maintenance during routine field operations on environmental projects. Site-specific deviations from the methods presented herein must be approved by the assigned HGL project manager and the HGL project quality assurance/quality control officer. Consult the project-specific planning documents for other documentation requirements that apply to the project.

## 3.0 GENERAL REQUIREMENTS

All project work must be performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements.

Any deviations from specified project requirements must be justified to and authorized by the project manager and/or the relevant program manager and documented in the planning documents after consultation and approval by the client (refer to change or variance documentation requirements in the planning documents). Deviations from requirements are documented sufficiently to re-create the modified process and/or product and associated approvals.

All field personnel present on site to conduct work related to environmental projects are responsible for documenting field activities in project field logbooks. If field personnel are working in teams, one team member should be assigned to document the work performed. Documentation in the logbooks must be legible, and the logbooks must be maintained over the course of the project in accordance with this SOP.

The HGL field team leader, or approved designee, prepares daily logs to provide clients records of significant events, observations, and measurements taken in the field. These daily logs rely on documentation from the logbooks and should match.

<b>Field Logbook Use and Maintenance</b>	<b>SOP No.: 300.04 (formerly 4.07)</b>
	<b>SOP Category: QA/QC</b>
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	<b>Review Date: November 2021</b>

The HGL field team leader should check logbook entries at the end of each field day to ensure that they are complete/adequate and communicate any deficiencies and corrective measures immediately. Logbook entries should be reviewed on a regular basis by the project manager or an approved designee to verify that they have been completed in accordance with this SOP. This could be done as part of the three-phase control inspections for each task or definable feature of work. Regular reviews of logbook ensure that adjustments to the information in the logbook, if needed, can be made early on in the performance of the task and establish expectations for documented information.

## **4.0 PROCEDURE**

### **4.1 INTRODUCTION**

Field logbooks provide a means for recording and documenting for the record observations and activities at a site. Field logbooks are intended to provide sufficient data and observation notes to enable participants to reconstruct events that occurred while performing field activities and to refresh the memory of field personnel when drafting reports or giving testimony during legal proceedings. As such, all entries must be as factual, detailed, and as descriptive as possible so that a particular situation can be reconstructed without reliance on the memory of field crews. Field logbooks are not intended to be used as the sole source of project or sampling information. A sufficient number of logbooks are assigned to a project to ensure that each field team has a logbook at all times.

### **4.2 FIELD LOGBOOK IDENTIFICATION**

Field logbooks are bound books with consecutively prenumbered pages. Logbooks are permanently assigned to field personnel for the duration of the project or sampling event. When not in use, the field logbooks are to be stored in site project files. If site activities stop for an extended period (2 weeks or more), field logbooks are stored in the project files in the appropriate HGL office. The field logbooks are scanned on a regular basis, grouped in files by field event and by logbook, and stored electronically in the proper project file located on SharePoint.

The cover of each logbook contains the following information:

- Organization to which the book is assigned (HGL),
- Site name (including operable unit designation),
- Project number,
- Book number, and
- Start and end dates of the information in the logbook.

### **4.3 LOGBOOK ENTRY PROCEDURES**

Every field team must have a logbook, and each field activity is recorded in the logbook by a designated field team member to provide daily records of significant events, observations, and

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	<b>Review Date: November 2021</b>

measurements during field operations. Beginning on the first blank page and extending through as many pages as necessary, the following list provides examples of useful and pertinent information that may be recorded (optional).

- Serial numbers and model numbers for equipment that will be used for the project duration,
- Formulas, constants, and example calculations,
- Useful telephone numbers, and
- County, state, and site address.

Entries into the logbook may contain a variety of information. At a minimum, the following information must be recorded on the first page of the logbook entry for each workday:

- Date (on all pages),
- Site name, site location, and project number,
- Weather at start of day and projected for the day (changes during the day should be documented at the time of the change),
- Names of field personnel and subcontractors present and directly involved in the field activities, with their initials in order to reference them by initials during the day to facilitate note taking,
- Level of personal protective equipment being used on the site,
- Equipment used and calibration procedures followed,
- Start time, and
- Any field calculations.

In addition, information recorded in the field logbook during the day includes, but is not limited to, the following:

- Sample description including sample numbers, collection time, depth, volume, type and number of containers, preservative, and media sampled;
- Information on field quality control samples (e.g., duplicates, trip blanks, rinsates, and matrix spike/matrix spike duplicates [MS/MSDs]);
- Sample courier airbill numbers and associated chains of custody numbers;
- Observations about site and samples (odors, appearances, etc.);
- Information about any activities, extraneous to sampling activities, that may affect the integrity of the samples;
- Any public involvement, visitors, or press interest, comments, or questions; as well as times present at site;
- Equipment used on site including time and date of calibration along with calibration gas/fluid lot numbers and expiration dates, and calibration results;

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	<b>SOP Category: QA/QC</b>
	<b>Revision No.: 3</b>
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	<b>Review Date: November 2021</b>

- Background levels of each instrument and possible background interferences;
- Instrument readings for the borehole, cuttings, or samples in the breathing zone and from the specified depth of the borehole, etc.;
- Field parameters (pH, specific conductivity, etc., as required by the sampling method and planning documents);
- Unusual observances, irregularities, or problems noted on site or with instrumentation used;
- Maps or photographs acquired or taken at the sampling site, including photograph numbers and descriptions;
- A photographic log that lists subject, person taking photograph, distance to subject, direction, time, photograph number, and noteworthy items for each photograph stating what feature/item the photo is documenting;
- A description of the investigation-derived waste (IDW) generated, the quantity generated, and the manner of IDW storage employed; and
- Forms numbers/titles and any information contained therein used during sampling (Note that a form does not take the place of the field logbook.).

All logbook entries are made in indelible black or blue ink. No erasures are permitted. If an incorrect entry is made, the data is crossed out with a single strike mark and initialed and dated by the originator. Entries are be organized into easily understandable tables if possible. A sample format is shown in Attachment 1. A Logbook Quick Guide, which provides logbook entry requirements and suggestions, is included as Attachment 2. This guide can be copied and taped to the inside cover of a logbooks for quick reference.

All logbook pages are initialed and dated at the top of each page. The time (in 12- or 24-hour format) is recorded next to each entry. No pages or spaces are left blank. If the last entry for a day is not at the end of a page, a diagonal line is drawn through the remaining space, and the line is signed and dated.

Logbooks can become contaminated when used in the field. Every effort should be made by the field team to avoid contaminating the logbook. Logbooks can be kept in seal-top poly bags, or temporary plastic covers may be used.

#### **4.4 REVIEW**

The assigned field team leader, or an approved designee, checks field logbooks for completeness and accuracy on an appropriate site-specific schedule determined by the project leader. Any discrepancies in the logbooks are noted and returned to the originator for correction. The originator or other field team member knowledgeable about the field task reviews the comments, makes

<b>Field Logbook Use and Maintenance</b>	<b>SOP No.: 300.04 (formerly 4.07)</b>
	<b>SOP Category: QA/QC</b>
	<b>Revision No.: 3</b>
	<b>Revision Date: November 20, 2019</b>
	<b>Review Date: November 2021</b>

appropriate revisions, and signs and dates them. The reviewer verifies that revisions have been made before placing the logbook photocopies on the project file in SharePoint.

## **5.0 REVISION HISTORY**

Revision 0		Initial Release
Revision 1	December 2010	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	July 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 3	November 20, 2019	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.

## **ATTACHMENTS**

Attachment 1 – Example Field Logbook  
Attachment 2 – Logbook Quick Guide

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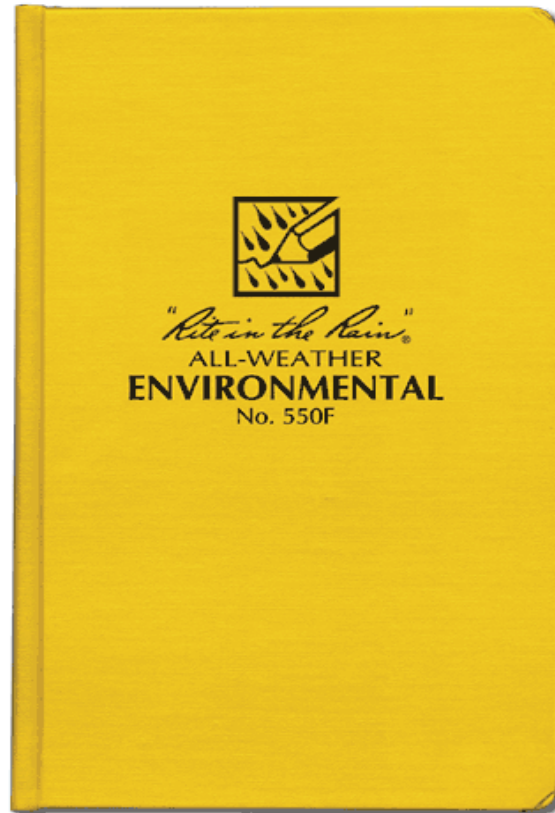
**ATTACHMENT 1**  
**EXAMPLE FIELD LOGBOOK**

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## ATTACHMENT 1

### Example Field Logbook

[illegible]

# INFORMATION RECORDED IN THE FRONT OF LOG

## DOES OPTIONAL

- serial model # of equipment (sensors)
- formulas, conversions, example calculations
- useful phone #s
- site address

## DAILY RECORDING REQUIREMENTS

- Initials and date (top of every page)
- start time
- weather
- depth methods (you may cross reference a previous days method if identical)
- personnel present on site
- pipe
- signatures of individual recording info
- equipment/procedures used
- sample descriptions (time, depth, volume, containers, preserv., etc.)
- GC samples (field and lab)
- observations
- field parameters
- maps/photos drawn or taken
- form #s
- handwritten paperwork

When using a field form information recorded in the field does not need to be written twice. Cross reference the field form # in the log book and record the information only on the appropriate field form.

## DO NOT LEAVE ANY BLANK SPACES/PAGES.

If a page is accidentally left blank or there is unused space at the end of a day's entry draw a diagonal line through the space and initial and date the line.

Photo log:  
 subject of photos  
 distance to subject  
 person taking photo  
 distance from each other  
 Time / place / date  
 photograph taken

Ann Vogel 11/10/95  
 November 6, 1995, AX1015.13.00  
 pH Meter  
 Hach  
 Model # = 12345  
 Serial # = 6789  
 Conductivity Meter  
 Hach  
 Model # = 12345  
 Serial # = 6789  
 $C^2 = a^2 + b^2$   
 if  $a = 3$   
 if  $b = 4$   
 then:  $a^2 = 3^2 = 9$   
 $b^2 = 4^2 = 16$   
 $c^2 = 9 + 16 = 25$   
 $c = \sqrt{25}$   
 $c = 5$   
 $r = 8.14159$   
 Anne Vogel home # 123-4567  
 105 Denver Office # 203/2996-9700  
 105 San Francisco # 415/774-2300 (home)  
 Smith Site  
 Boulder County, Colorado  
 Address: 1234 W. Main Street  
 Mountain, Colorado 80000  
 Directions to Site:  
 West on I-70  
 Exit 95B  
 Head South approx. 3 miles  
 Site is on east side of dirt road

AV 11/6/95

2

November 6, 1995 Site Visit

0700 Arrive on site

Weather: 80°, sunny, slight breeze (~5 mph) from southwest

VOS Field Team: EPA OSC:

M.R. Smith

K.W. Wagner

P.R. Lane

PRP representative, L.M. Stein, will be accompanying the VOS Field Team.

Personal Protective Equipment - LEVEL D

will be used on-site (refer to site-specific health & safety plan).

All equipment will be decontaminated as follows:

- Brush equipment scrub brush to remove gross particulates.

- Scrub thoroughly with Alconox/ water solution.

- Rinse with reagent-grade distilled water.

- Rinse with reagent-grade Methanol.

- Rinse with reagent-grade distilled water.

Allow equipment to gravity drain

Wrap equipment in tinfoil if not immediately used.

Sample procedure:

All surface water samples will be

taken using a clean decontaminated

TEFLON scoop; stainless steel spoon

and stainless steel bowl will be

used for sediment samples.

AV 11/6/95

3

The samples will be taken from the ponds at the center of the dam opposite the outlets. (see below);

refer to sample plan.

All total suspended solids (TSS) samples

will be collected in a 500 ml

polystyrene bottle - No preservative

is necessary.

All VOA samples will be collected in

two 40-ml amber glass vials and

will be collected first. Preservation

will be 4°C (ice).

→ Meters (pH) Decon = Rinse with

reagent-grade distilled water



AV 11/6/95  
4

11/6/95 AV  
5

Time Sample	Sample #	Label #	FIELD PARAMETERS
0802	V0A	81088 V0A	TIME PH Conductivity
0803	TSS	81088 TSSA	0924 6.00 590
Decon equipment (scoop only)			Decon meters as noted on page 3 of this logbook.
* Label 102 fell in mud - destroyed it.			Fill out surface water quality sheet.
Field Parameters			
Time	PH	Conductivity	
0815	6.35	610	
Decon equipment (meters only)			0940 - Leave Pond B - head back to trailer to pack samples for shipment.
Fill out surface water quality sheet.			0952 - Arrive at Trailer.
Note - wind speed is picking up - The ponds became turbulent.			0959 - Complete chain-of-custody forms for samples to be shipped.
0839 - Leave Pond A - go to Pond B.			Wrap Samples according to VOS TSOB.
0840 - Arrive at Pond B			1020 - Seal Cooler and attach Custody seals.
Pond B sampling procedure.			1030 - Take cooler to Federal Express for shipping.
0842 - Decon equipment.			CAL # 1334507.
Calibrate pH meter			1035 - Leave Federal Express.
Time	STD	Reading	Sampling Complete.
0844	4.00	4.00 Rinse Probe	
0845	7.00	7.00 Rinse Probe	
0847 Calibrate conductivity meter using 10000 STD - Rinse probe.			
Decon sampling equipment (scoop).			
Time Sample			Label #
0902	V0A	81088 V0A BD	106
0903	TSS	81088 TSS BD	107
0903 Decon scoop.			
Rinse Samples			
Time Sample			Sample # Label #
0920	V0A	81088 V0A	107-108

11/6/95

**ATTACHMENT 2**  
**LOGBOOK QUICK GUIDE**

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## LOGBOOK QUICK GUIDE

### TOP

---

Location: County/City/State

Project/Client: Project/Client Name

### MINIMAL REQUIREMENTS

---

- times of activities (military)
- author of day's entries
- field team members
- field team member assignments
- field activities
- EPA or other regulatory personnel observing - activities
- other personnel
- public or press visitors
- equipment used
- equipment calibration information
- serial numbers of equipment
- weather
- decontamination methods
- level of PPE
- calculations used
- **sample information**
  - ID
  - depth
  - volume
  - containers
  - preservative
  - media
  - QC samples

## LOGBOOK QUICK GUIDE

### MINIMAL REQUIREMENTS (cont.)

---

- background levels and readings
- possible instrument interferences
- photographs
  - + number
  - + direction
  - + description
  - + photographer

### OTHER REQUIREMENTS

---

- unusual observations
- strike through mistakes with single line
- diagonal line across unused portion of page with signature and date
- use indelible black or blue ink
- no erasable ink
- generate tables when possible for information
- leave no pages blank
- place North arrow on sketches
- leave no open lines
- staple business cards of visitors in book
- deviations from approved plans
- field forms completed

\* *Black text applies to all activities*


\* *Red text applies to activities that include sampling*

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**SOP 403.02, SIB Project Area, PHSS**  
**(Source: Hand-Operated Auger Soil Sampling)**

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	<b>STANDARD OPERATING PROCEDURE</b>	
	Approved by: <b>Jeff Dick</b>	Digitally signed by Jeff Dick DN: cn=Jeff Dick, o, ou, email=jdick@hgl.com, c=US Date: 2019.08.02 07:28:29 -04'00' Corporate Quality Manager
<b>Hand-Operated Auger Soil Sampling</b>	<b>SOP No.: 403.02 (formerly 2.03)</b>	
	<b>SOP Category: Environmental Services</b>	
	<b>Revision No.: 2</b>	
	<b>Revision Date: August 1, 2019</b>	
	<b>Review Date: August 2021</b>	

## 1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the standard method and equipment used to collect soil samples at the surface or in shallow subsurface using a hand auger.

## 2.0 SCOPE AND APPLICATION

This procedure yields a disturbed sample and applies to a wide variety of soil types including sands, clays, and silts. A hand auger is typically a small, lightweight metal cylinder (bucket), open at both ends with a cutting bit on the bottom. Diameters typically range between 1 and 4 inches. A T-shaped handle is attached to the top of the bucket by extendable rods. The augers are rotated into the ground until the bucket is full, then lifted out of the borehole and emptied. The maximum depth of hand auger investigations is typically 10 feet below ground surface. The use of an auger is of limited value in rocky soil. This procedure is not appropriate for collecting samples at a discrete depth, but may be used to collect samples at an approximate depth.

## 3.0 GENERAL REQUIREMENTS

All work must be performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements.

Any deviations from specified requirements must be justified to and authorized by the project manager and/or the relevant program manager. Deviations from requirements must be sufficiently documented to re-create the modified process.

## 4.0 EQUIPMENT

The equipment required may include hand-operated, spiral-type, ship-type, open-tubular, orchard-barrel, open-spiral, closed-spiral, post-hole, clamshell, Edelman, or Iwan augers. Augers typically are used with 3- to 4-foot-long metal extension rods and T-handles (fixed or ratcheted). The use of stainless steel augers is preferred. Augers plated with chrome or coated with other materials, except Teflon<sup>®</sup>, cannot be used.

Sampling tools and equipment should be protected from contamination sources before sampling and decontaminated before and between sampling locations, as specified in SOP 2.01: *Sampling Equipment Cleaning and Decontamination*.

<b>Hand-Operated Auger Soil Sampling</b>	<b>SOP No.: 403.02 (formerly 2.03)</b>
	<b>SOP Category: Environmental Services</b>
	<b>Revision No.: 2</b>
	<b>Revision Date: August 1, 2019</b>
	<b>Review Date: August 2021</b>

## 5.0 PROCEDURES

1. Don clean gloves. Using a decontaminated stainless steel spoon or other approved utensil, remove surface vegetation and debris from the immediate area around the marked sampling point.
2. Do not allow sampling equipment to touch potentially contaminated surfaces.
3. Record the appropriate information and observations about the sample location in the field logbook.
4. Assemble the decontaminated auger, extension, and T-handle, if necessary, and advance the auger into the soil to the desired depth. Mark the length of the hand auger rods every 0.5 foot to determine auger head depth relative to the ground surface when advancing or tag the bottom of the borehole (if the borehole stays open) with a weighted tape measure or water level meter.
5. Withdraw the auger from the soil.
6. If a sample is not being collected, remove the soil from the auger bucket and repeat Steps 4 and 5. While removing the soil from the auger bucket, the subsurface lithology should be described as specified in SOP 2.14: *Geologic Borehole Logging*. If a sample is to be collected in the next depth interval, replace the auger bucket with a clean decontaminated bucket and repeat Steps 2 through 4. Change gloves at each sampling location, or each time a new sample is to be collected, to avoid cross-contamination.
7. Perform any field monitoring required in the project-specific planning documents.

If collecting samples for analyses other than volatile organic compound (VOC) analyses, refer to Steps 8 and 9.

8. Using a decontaminated stainless steel spoon, spatula, disposable scoop, remove soil from the auger bucket and place in a stainless steel or glass container. Food-grade disposable aluminum pans may also be used but cannot be reused. Clean nitrile gloves may be donned to remove soil from the auger bucket by hand. Discard the top 2 or 3 inches of soil in the auger as this soil may consist of borehole slough from above. Mix or composite soil as directed by the project-specific planning documents. Using a decontaminated spoon or other approved utensil, remove any large rocks or other organic material (worms, grass, leaves, roots, etc.). Clean nitrile gloves may also be donned to remove large rocks or other organic material by hand.
9. Using a decontaminated stainless steel spoon, spatula, or disposable scoop, as appropriate, place soil samples in appropriate containers. Clean nitrile gloves may be donned to place soil into appropriate containers. Place samples in containers defined according to analytical

<b>Hand-Operated Auger Soil Sampling</b>	<b>SOP No.: 403.02 (formerly 2.03)</b>
	<b>SOP Category: Environmental Services</b>
	<b>Revision No.: 2</b>
	<b>Revision Date: August 1, 2019</b>
	<b>Review Date: August 2021</b>

needs specified in the project-specific planning documents, label samples, and then (when appropriate) pack on ice as soon as possible.

If collecting samples for VOC analysis, refer to Steps 10 and 11.

10. Remove the hand auger from the boring when the top of the specified sampling depth has been reached. Fit a slide-hammer to the top of the appropriate number of extension rods required to reach the total depth of the hole. Attach an impact sampler to the bottom of the extension rod(s) and drive the impact sampler into the soil to a depth of at least 6 inches. Remove the sampler from the borehole.
11. Collect VOC samples in accordance with SOP 403.01.0: *VOC Soil Sample Collection*. When samples are being collected for multiple analyses, samples that can be degraded by aeration (e.g., VOCs) are collected first and with the least disturbance possible to minimize analyte loss. VOC samples must not be composited.

## 6.0 REVISION HISTORY


Revision 0	December 2010	Initial Release
Revision 1	April 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	August 1, 2019	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.

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**SOP 403.03, SIB Project Area, PHSS**  
**(Source: Soil or Sediment Sample Compositing)**

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	<b>STANDARD OPERATING PROCEDURE</b>	
	Approved by: <b>Jeff Dick</b>	Digitally signed by Jeff Dick DN: cn=Jeff Dick, o, ou, email=jdick@hgl.com, c=US Date: 2019.08.02 07:30:04 +04'00' Corporate Quality Manager
<b>Soil or Sediment Sample Compositing</b>	<b>SOP No.: 403.03 (formerly 2.04)</b>	
	<b>SOP Category: Environmental Services</b>	
	<b>Revision No.: 4</b>	
	<b>Revision Date: August 1, 2019</b>	
	<b>Review Date: August 2021</b>	

## 1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to outline methods that may be used for field compositing soil or sediment samples before they are submitted to an analytical laboratory.

## 2.0 SCOPE

This procedure applies to compositing soil or sediment. This procedure does not apply to sample collection, but rather to combining samples in preparation for submittal for testing. Samples for volatile organic compound analyses must NOT be composited.

## 3.0 GENERAL REQUIREMENTS

All work must be performed in accordance with the site- or project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements.

Any deviations from specified requirements must be justified to and authorized by the project manager and/or the relevant program manager. Deviations from requirements must be sufficiently documented to re-create the modified process.

## 4.0 PROCEDURES

Soil or sediment that is to be sampled must be mixed as thoroughly as possible before being transferred to the sample container. Anomalous or suspected highly contaminated samples must be brought to the attention of the field manager.

- Soil or sediment that is composited must meet the following requirements:
  - Uniform collection techniques must be used to retrieve sample aliquots.
  - Aliquots must be of equal or known proportion.
  - The soil or sediment must be well mixed.
- The most common method of mixing (compositing) is referred to as quartering. The soil or sediment is placed in a pan or tray and divided into quarters. Each quarter is mixed individually, and then all quarters are mixed together to form a homogenous matrix. This procedure is repeated several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the soil or sediment in a circular fashion and occasionally turning the soil or sediment over. Mixing bowls and

<b>Soil or Sediment Sample Compositing</b>	<b>SOP No.: 403.03 (formerly 2.04)</b>
	<b>SOP Category: Environmental Services</b>
	<b>Revision No.: 4</b>
	<b>Revision Date: August 1, 2019</b>
	<b>Review Date: August 2021</b>

stirring devices must be stainless steel and be decontaminated prior to use. Samples are homogenized before being placed into containers, except for volatile organic analyses.

- Sampling tools, instruments, and equipment must be protected from contamination sources before use and decontaminated after use as specified in SOP 2.01: *Sampling Equipment Cleaning and Decontamination*.
- Composite samples must be packaged, labeled, and prepared for shipment in accordance with the project-specific planning documents.
- The field logbook must be completed in accordance with procedures detailed in SOP 4.07: *Field Logbook Use and Maintenance*.

## 5.0 RECORDS

Documentation generated as a result of this procedure must be collected and maintained in accordance with requirements specified in the project-specific planning documents.

- Complete the field logbook in accordance with procedures listed in SOP 4.07: *Field Logbook Use and Maintenance*.

## 6.0 REVISION HISTORY

Revision 0		Initial Release
Revision 1		Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	April 2009	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 3	April 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 4	August 1, 2019	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.

**SOP 403.04, SIB Project Area, PHSS**  
**(Source: Direct-Push Technology Soil and Groundwater Sampling)**

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	<b>STANDARD OPERATING PROCEDURE</b>	
	Approved by: <b>Dick, Jeff</b>	Digitally signed by Dick, Jeff Date: 2020.06.18 16:04:57 +04'00'
<b>Direct-Push Technology Soil and Groundwater Sampling</b>	<b>SOP No.: 403.04 (formerly 2.05)</b>	
	<b>SOP Category: Environmental Services</b>	
	<b>Revision No.: 3</b>	
	<b>Revision Date: June 18, 2020</b>	
	<b>Review Date: June 2022</b>	

## 1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the standard method and equipment used to collect soil and groundwater samples using direct-push technology (DPT).

## 2.0 SCOPE AND APPLICATION

The DPT soil sampling method applies to a wide variety of soil types including sands, clays, and silts. Samples may be collected from discrete intervals where high sample recovery rates can be achieved such as in clays and silts. However, where sample recovery rates are low, such as may be the case in loose sand, the sample collection depth intervals may be approximate. DPT soil sampling methods are of limited value in rocky soil. Where rocky soils limit the use of DPT, a different technology, such as hollow-stem auger drilling equipment, must be used. This procedure is appropriate for collecting groundwater samples at discrete depths.

## 3.0 GENERAL REQUIREMENTS

All work must be performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan and project-specific quality assurance project plan for relevant health and safety and quality control requirements, respectively.

Any deviations from specified requirements must be justified to and authorized by the project manager and/or the relevant program manager. Deviations from requirements must be sufficiently documented to re-create the modified process.

## 4.0 PRECAUTIONS

The following precautions should be employed during DPT sampling operations:

- Subsurface and aboveground utility lines must be identified and cleared before exploratory boring drilling activities can be performed. Procedures outlined in HGL SOP 411.03: *Subsurface Utility Avoidance*, must be followed.
- Every attempt should be made to minimize the transfer of potentially contaminated material to downhole equipment, or to any equipment and supplies stored on the site.
- Every attempt should be made to contain contaminated soil and water and to prevent further contamination of the environment.

<b>Direct-Push Technology Soil and Groundwater Sampling</b>	<b>SOP No.: 403.04 (formerly 2.05)</b>
	<b>SOP Category: Environmental Services</b>
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	<b>Review Date: June 2022</b>

- Sampling tools and equipment must be protected from sources of contamination before sampling and decontaminated before and between sampling, as specified in SOP 411.02: *Sampling Equipment Cleaning and Decontamination*.

## 5.0 DPT SAMPLING PROCEDURES

DPT soil sampling is accomplished using a Geoprobe® or other similar truck- or track-mounted hydraulic sampler. DPT involves advancing a sampling probe using direct hydraulic pressure or a hydraulically driven rotary hammer. Boreholes are typically advanced using a 2.5- to 3-inch-diameter lead sampler attached to 1- or 2-inch-diameter probe rods, which are placed under hydraulic downward pressure. In unstable soils, a dual-tube system may be used where the lead sampler and center rods are used within larger diameter probe rods to prevent caving of material into the sample interval. Sampler sizes can vary from 1.25 to 4.5 inches in outer diameter (OD); however, 2.25- to 3.25-inch OD samplers are typical. Liner sizes can vary from 1.0 to 3.0 inches in internal diameter (ID); however, 1.125- to 1.85-inch ID liners are typical. Borings remain open only as long as necessary to collect the soil and/or groundwater samples and log the lithology, if required by the project-specific planning documents.

Specific sampling tools could require slightly different handling methods. For example, if sampling devices and probe rod extensions do not have quick-connect fittings, adjustable or pipe wrenches could be needed to change equipment configurations. The procedures described in this SOP are for power-driven DPT methods or tube samplers, and they are consistent with ASTM International Standard Guides D6282/D6282M-14 and D6001-05(2012).

### 5.1.1 Soil Sampling Procedures

The soil samples obtained using DPT are collected in acetate, brass, or stainless steel sampling tubes. Acetate tubes are most commonly used. Sampling is initiated at the soil interface, unless otherwise specified in the project-specific planning documents.

- Place plastic sheeting on the ground around the sampling location to prevent cross contamination.
- Attach the direct-push sampler with liner and cutting shoe to a rod extension.
- Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). Remove the first 8 to 15 centimeters (cm) of surface soil from an approximately 15-cm radius around the drilling location to prevent near-surface soil particles from falling down the hole.
- Begin advancing the direct-push sampler, periodically removing accumulated soils. This step prevents accidentally brushing loose material back down the borehole when removing the sampler or adding probe rods.

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- After reaching the desired depth, slowly and carefully remove the direct-push tool from the boring. If collecting a core sample, remove the cutting shoe and liner from the sampler and replace it with a precleaned thin-walled tube sampler. Insert a disposable acetate liner into the sampler with optional core catcher, and install the sampler and cutting shoe.
- Carefully lower the sampler down the borehole and gradually force the sampler into the soil. Care should be taken to avoid scraping the borehole sides when not using a dual-tube system. Hammering the probe rods to facilitate coring should be avoided, as the vibrations could cause the borehole walls to collapse.
- Once the sampler reaches the top of the sampling interval, drive the sampler down into the soil the length of the corer.
- Pull the probe rods and sampler out of the hole.
- Remove the sampler by twisting to prevent losing the core and unscrew the probe rods.
- Remove the cutting shoe and remove the acetate liner containing the core from the device.
- Carefully cut the acetate liner to expose the core.
- Screen the core with a field detector as described in the project-specific planning documents. If required by the project plans, collect volatile organic compound (VOC) samples immediately after opening the acetate liner. VOC samples must be collected in accordance with SOP 403.01: *VOC Soil Sample Collection*.
- Discard the top of the core (approximately 2.5 cm), as it will contain any material collected by the corer before penetration of the layer being sampled.
- Provide a lithologic description in accordance with SOP 403.07: *Geologic Borehole Logging*.
- If homogenization of the soil sample is appropriate for the remaining analytical parameters, or if compositing of different locations is desired, follow the procedures detailed in SOP 403.03: *Soil or Sediment Sample Compositing*. Otherwise, transfer the sample into an appropriate container with a stainless steel spoon or equivalent and secure the cap tightly.
- Label the sample bottle(s) with the appropriate sample label as described in the project-specific planning documents. Complete the label carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately.
- Complete all chain of custody documents and record information in the field logbook in accordance with procedures listed in SOP 300.04: *Field Logbook Use and Maintenance* and on the Field Sampling Report (Attachment 1).
- Prepare the samples for shipment in accordance with the project-specific planning documents.

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	<b>Revision Date: June 18, 2020</b>
	<b>Review Date: June 2022</b>

- Decontaminate sampling equipment after use and between sampling locations in accordance with procedures detailed in SOP 411.02: *Sampling Equipment Cleaning and Decontamination*.
- If no more cores are needed from the borehole, abandon the borehole with bentonite grout or chips and return the surface to its initial condition (e.g., topsoil, asphalt, or pavement).
- Soil generated during DPT activities that was not used for sampling should be treated as investigation-derived waste (IDW) and managed in accordance with the project-specific planning documents.

### 5.1.2 Groundwater Sampling Procedures

DPT groundwater samples can be collected using a hydropunch sampler. This type of groundwater sampling is best used for characterizing a site to determine the best placement of permanent wells. Procedures for collecting a water sample with a hydropunch are discussed in detail in this section. Note that the hydraulic conductivity of a formation could affect the time required to collect a sample. That is, more time could be required if groundwater recharge is slow. In those instances, the probe rods and hydropunch sampler can remain in the ground while the rig moves to another location to allow the water to recharge. After sufficient recharge, bailing or pumping can begin again.

- Place plastic sheeting on the ground around the sampling location to prevent cross contamination.
- Attach the sealed-screen sampler (hydropunch) to the probe rods.
- Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). Remove the first 8 to 15 cm of surface soil from an approximately 15-cm radius around the drilling location to prevent near-surface soil particles from falling down the hole.
- Begin advancing the hydropunch. The screen is driven to a depth such that the middle of the screen is set at the sample target depth.
- After reaching the desired depth, retract the protective outer rod of the sampler to expose the screen to groundwater. If necessary, an instrument can be lowered down through the center of the probe rods to check the water level and ensure that the sampler has sufficient water for sampling.
- Lower tubing with check valve, bailer, or peristaltic pump down through the probe rods to the screen of the hydropunch to collect the groundwater sample. Groundwater samples are collected most commonly using polyethylene or Teflon<sup>®</sup> tubing with a check valve attached to the bottom. An up/down oscillating motion on the tubing pumps the water column up in the tubing to the ground surface or until enough water volume is in the tubing for the samples. Groundwater samples are collected directly from the bottom of the tubing, after removing the check valve, and placed in sample containers according to the project-specific planning documents.



<b>Direct-Push Technology Soil and Groundwater Sampling</b>	<b>SOP No.: 403.04 (formerly 2.05)</b>
	<b>SOP Category: Environmental Services</b>
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	<b>Revision Date: June 18, 2020</b>
	<b>Review Date: June 2022</b>

- Unless otherwise specified in the project-specific planning documents, collect the groundwater samples without purging sediment or groundwater to minimize disturbance to the sample.
- If sediment is expected in the sample, consider using sample containers without a hydrochloric acid preservative. Mixing the sediment often found in direct push groundwater samples with the hydrochloric acid causes a reaction that generates a gaseous product that creates unwanted headspace in the groundwater sample.
- If a bailer is used, retrieve the sample from the bailer and place it in an appropriate sample container.
- If a peristaltic pump is used, fill the appropriate sample container from the pump effluent tubing.
- If required, place a portion of the sample in a container to collect field parameters (temperature, pH, conductivity, dissolved oxygen, oxygen reduction potential, and turbidity).
- Label the sample bottles with the appropriate sample labels as described in the project-specific planning documents. Complete the label carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately.
- Complete all chain of custody documents and record information in the field logbook in accordance with procedures listed in SOP 300.04: *Field Logbook Use and Maintenance* and on the Field Sampling Report (Attachment 1).
- Prepare samples for shipment in accordance with the project-specific planning documents.
- Pull the rods and hydropunch sampler from the hole.
- Decontaminate sampling equipment after each use and between sampling locations in accordance with procedures detailed in SOP 411.02: *Sampling Equipment Cleaning and Decontamination*.
- If additional samples are not needed from the borehole, abandon the borehole with bentonite chips and return the surface to its initial condition (e.g., topsoil, asphalt, or pavement).
- Manage IDW generated during hydropunch sampling in accordance with the project-specific planning documents.

## 6.0 RECORDS

Documentation generated as a result of this SOP must be collected and maintained in accordance with requirements specified in the project-specific planning documents.

<b>Direct-Push Technology Soil and Groundwater Sampling</b>	<b>SOP No.: 403.04 (formerly 2.05)</b>
	<b>SOP Category: Environmental Services</b>
	<b>Revision No.: 3</b>
	<b>Revision Date: June 18, 2020</b>
	<b>Review Date: June 2022</b>

- Document all daily field activities in the field logbook in accordance with procedures listed in SOP 300.04: *Field Logbook Use and Maintenance*.
- Complete a Field Sampling Report (Attachment 1) for each soil and groundwater sample.

## 7.0 REFERENCES

ASTM International (ASTM). D6282/D6282M-14: Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations.

ASTM. D6001-05(2012): Standard Guide for Direct-Push Groundwater Sampling for Environmental Site Characterization.

## 8.0 REVISION HISTORY

Revision 0	April 2009	Initial Release
Revision 1	April 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	February 2018	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 3	June 18, 2020	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting, which included changing the SOP number from 2.05 to 403.04.

## ATTACHMENTS

Attachment 1 – Field Sampling Report

**ATTACHMENT 1**  
**FIELD SAMPLING REPORT**

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## FIELD SAMPLING REPORT

LOCATION:		PROJECT NAME:																													
SITE:		PROJECT NO:																													
<b>SAMPLE INFORMATION</b>																															
SAMPLE ID:		DATE: _____ TIME: _____																													
MATRIX TYPE:		ENTER SAMPLE NUMBERS FOR QC SAMPLES/ BLANKS ASSOCIATED WITH THIS SAMPLE:  MATRIX SPIKE (MS): _____  MATRIX SPIKE DUP (SD): _____  FIELD DUP (FD): _____  AMBIENT BLANK (AB): _____  EQUIPMENT BLANK (EB): _____  TRIP BLANK (TB): _____																													
SAMPLE COLLECTION METHOD:																															
LOW-FLOW    BAILER    PASSIVE    OTHER _____																															
LOT CONTROL #: _____ (Ambient Blank # - Equipment Blank # - Trip Blank # - Cooler #)																															
CHAIN-OF-CUSTODY #: _____																															
SAMPLE BEG. DEPTH (FT): _____ SAMPLE END DEPTH (FT): _____ GRAB ( )    COMPOSITE ( )																															
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 15%;">CONTAINER</th> <th style="width: 10%;">PRESERVATIVE/ PREPARATION</th> <th style="width: 20%;">ANALYTICAL METHOD</th> <th style="width: 55%;">ANALYSIS</th> </tr> <tr> <td>SIZE/TYPE    #</td> <td></td> <td></td> <td></td> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>		CONTAINER	PRESERVATIVE/ PREPARATION	ANALYTICAL METHOD	ANALYSIS	SIZE/TYPE    #																									
CONTAINER	PRESERVATIVE/ PREPARATION	ANALYTICAL METHOD	ANALYSIS																												
SIZE/TYPE    #																															
<b>NOTABLE OBSERVATIONS</b>																															
PID READINGS		SAMPLE CHARACTERISTICS																													
1st (TOC): _____		COLOR: _____																													
2nd (BZ): _____		ODOR: _____																													
		OTHER: _____																													
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="2">pH _____</td> <td>Temperature _____ (C)</td> <td>Dissolved Oxygen _____ (mg/L)</td> <td>Specific Conductivity _____ (mS/cm)</td> </tr> <tr> <td colspan="2">Ferrous Iron _____ (mg/L)</td> <td>Oxidation/Reduction Potential _____ (mv)</td> <td colspan="2">Turbidity _____ (NTU)</td> </tr> </table>				pH _____		Temperature _____ (C)	Dissolved Oxygen _____ (mg/L)	Specific Conductivity _____ (mS/cm)	Ferrous Iron _____ (mg/L)		Oxidation/Reduction Potential _____ (mv)	Turbidity _____ (NTU)																			
pH _____		Temperature _____ (C)	Dissolved Oxygen _____ (mg/L)	Specific Conductivity _____ (mS/cm)																											
Ferrous Iron _____ (mg/L)		Oxidation/Reduction Potential _____ (mv)	Turbidity _____ (NTU)																												
<b>GENERAL INFORMATION</b>																															
WEATHER:    SUN/CLEAR _____ OVERCAST/RAIN _____ WIND DIRECTION _____ AMBIENT TEMPERATURE _____																															
SHIPMENT VIA:    FEDEX _____ HAND DELIVER _____ COURIER _____ OTHER _____																															
SHIPPED TO: _____																															
COMMENTS: _____																															
SAMPLER: _____ OBSERVER: _____																															
<b>MATRIX TYPE CODES</b>		<b>SAMPLE COLLECTION METHOD CODES</b>																													
DC=DRILL CUTTINGS                      SL=SLUDGE WG=GROUND WATER                      SO=SOIL LH=HAZARDOUS LIQUID WASTE    GS=SOIL GAS SH=HAZARDOUS SOLID WASTE    WS=SURFACE WATER SE=SEDIMENT                              SW=SWAB/WIPE W=WATER		B=BAILER                                      HA=HAND AUGER BP=GAS OPERATED BLADDER PUMP    HY=HYDRASLEEVE CS=COMPOSITE SAMPLE                      NS=NON-SUBMERSIBLE PUMP EC/TC=ENCORE/TERRA CORE SAMPLER    PP=PERISTALTIC PUMP GB=GEOPROBE                                SP=SUBMERSIBLE PUMP H=HOLLOW STEM AUGER                      SS=SPLIT SPOON OTHER    G = GRAB                      TR=TROWEL																													

**SOP 403.06, SIB Project Area, PHSS**  
**(Source: Surface and Shallow Depth Soil Sampling)**

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	<b>STANDARD OPERATING PROCEDURE</b>	
	Approved by: <b>Dick, Jeff</b>	Digitally signed by Dick, Jeff Date: 2020.06.25 08:10:05 -0400 Corporate Quality Manager
<b>Surface and Shallow Depth Soil Sampling</b>	<b>SOP No.: 403.06 (formerly 2.13)</b>	
	<b>SOP Category: Environmental Services</b>	
	<b>Revision No.: 3</b>	
	<b>Revision Date: June 24, 2020</b>	
	<b>Review Date: June 2022</b>	

## 1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the equipment and operations used for sampling surface and shallow depth soils. This procedure outlines the methods for soil sampling with routine field operations on environmental projects.

## 2.0 SCOPE AND APPLICATIONS

The objective of surface and shallow depth soil sampling is to ascertain the nature and extent of soil contamination at a site. The data can be used to identify contaminant sources, evaluate potential threats to human health or the environment, evaluate potential exposure pathways, or calculate environmental risks. For the purposes of this SOP, soil is defined as all unconsolidated materials above bedrock; surface soils are those that occur 0 to 6 inches below ground surface; and shallow depth soils are soils located above the bedrock surface and from 6 inches to 2 feet below ground surface.

## 3.0 GENERAL REQUIREMENTS

All work is performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements.

Any deviations from specified requirements must be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements must be documented sufficiently to re-create the modified process.

## 4.0 PROCEDURES

### 4.1 SAMPLING EQUIPMENT

Typically, equipment required for surface and shallow depth soil should be specified in the project field sampling plan or work plan. Equipment includes the following:

- Stainless steel mixing bowl,
- Stainless steel trowels or spoons,
- Stainless steel hand auger,
- Stainless steel core sampler that uses stainless steel or Lexan® liners (optional),
- Stainless steel shovel, and
- Appropriate sample containers.

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Disposable sampling equipment items, such as a sampling spoon, may be used instead of stainless steel equipment. An example of a hand auger is provided in Attachment 1.

## 4.2 DECONTAMINATION

Before initial use, and after each subsequent use, all nondedicated or nondisposable sampling equipment must be decontaminated using the procedures outlined in HGL SOP 411.02: *Sampling Equipment Cleaning and Decontamination*.

## 4.3 SAMPLING LOCATION/SITE SELECTION

Follow the sample design criteria outlined in the project plan for each sampling event. Relocate the sample sites when conditions dictate, such as when natural or artificial obstructions are present at the proposed sample location (such as boulders or asphalt). Document the actual sample locations on a topographic map or site sketch and photograph all sample locations. GPS coordinates for the new location may also need to be recorded.

## 4.4 GENERAL

All boreholes and pits are filled in with the material removed during sampling unless otherwise specified in the project-specific planning documents. Where a vegetative turf has been established, fill in with native soil or potting soil and replace the turf if practical in all holes or trenches when sampling is completed.

### 4.4.1 Homogenizing Samples

Homogenizing is the mixing of a sample to provide a uniform distribution of the contaminants. Proper homogenization ensures that the containerized samples are representative of the total soil sample collected. All samples to be composited or split should be homogenized after all aliquots have been combined. **Do not homogenize (mix or stir) samples for volatile compound analysis. Follow the procedures outlined in HGL SOP 403.01: VOC Soil Sample Collection for collection of such samples.**

### 4.4.2 Compositing Samples

Compositing is the process of physically combining and homogenizing several individual soil aliquots of the same volume or weight. Compositing samples provide an average concentration of contaminants over a certain number of sampling points. Refer to HGL SOP 403.03: *Soil or Sediment Sample Compositing*.

### 4.4.3 Splitting Samples

Splitting samples is performed when multiple portions of the same samples must be analyzed separately. After preparation, fill the sample containers for the same analyses one after another in

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a consistent manner (parent sample for semivolatile organic compounds [SVOCs] analysis, then split sample for SVOC analysis; parent sample for total metals analysis, then split sample for total metals analysis; and so forth).

#### 4.5 SURFACE SOIL SAMPLING

Perform the following steps for surface soil sampling:

- Before sampling, remove leaves, grass, and surface debris from the area using a decontaminated stainless steel trowel or disposable sampling spoon.
- Label the lid of the sample container with an indelible pen or affix the sample label to the side of the jar. Tape over the label to seal out dirt and water before filling the container with soil, if possible.
- Collect surface soil samples with a decontaminated stainless steel trowel, spoon, or hand auger and transfer them to a decontaminated stainless steel bowl for homogenizing. If VOC analyses are to be conducted, collect the VOC sample first following the procedures outlined in HGL SOP 403.01: *VOC Soil Sample Collection*, then transfer the appropriate aliquot of soil to the decontaminated stainless steel bowl for homogenizing.
- Collect samples in the order of volatilization sensitivity. The most common collection order is as follows:
  - VOC,
  - Purgeable organic carbon,
  - Purgeable organic halogens,
  - Total organic halogens,
  - Total organic carbon,
  - Extractable organics,
  - Total metals,
  - Phenols,
  - Cyanide, and
  - Radionuclides.
- Immediately transfer the sample into a container appropriate to the analysis being performed.
- Place the samples in a cooler with ice. The temperature in the cooler must be maintained at approximately 4°C (if appropriate for analyses) for transport to an analytical laboratory.
- Material removed to collect the samples is returned to the boreholes and pits. Excess soil sample media should be treated as investigation-derived waste (IDW) and managed in accordance with the project-specific planning documents.
- Decontaminate all sampling equipment following HGL SOP 411.02, *Sampling Equipment Cleaning and Decontamination*.

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	<b>Review Date: June 2022</b>

#### 4.6 SURFACE SOIL SAMPLING (COMPOSITE SAMPLES ONLY)

Perform the following steps for surface soil (composite) sampling:

- Before sampling, remove leaves, grass, and surface debris from the area using a decontaminated stainless steel trowel.
- Collect surface soil aliquots with a decontaminated stainless steel spoon, trowel, or hand auger and place them in a stainless steel bowl and homogenize. Homogenize the sample in accordance with HGL SOP 403.03: *Soil or Sediment Sample Compositing*. Follow the procedures outlined in HGL SOP 403.01: *VOC Soil Sample Collection*, for samples collected for VOC analysis.
- Label the sample container and place it in a cooler chilled to 4°C . Complete the chain of custody record and pack it in the sample cooler.
- Material removed to collect the samples is returned to the boreholes and pits. Excess soil sample media IDW should be managed in accordance with the project-specific planning documents.
- Decontaminate all nondedicated sampling equipment following HGL SOP 411.02: *Sampling Equipment Cleaning and Decontamination*.

#### 4.7 SHALLOW DEPTH SOIL SAMPLING

Perform the following steps to collect shallow depth soil samples:

- Use a decontaminated stainless steel shovel to remove the top layer of soil and leaves, grass, and surface debris.
- Excavate soil to the pre-determined sampling depth using a decontaminated hand auger. Periodically remove the cuttings from the auger.
- When the proper sample depth is reached, remove the hand auger and all cuttings from the hole.
- Lower the decontaminated core sampler or hand auger to the bottom of the hole. When using a core sampler, it must contain a decontaminated liner appropriate for the constituents to be analyzed.
- Mark the sample interval on the hammer stem or auger.
- Operate the slide hammer on the core sampler to drive the sampler head into the soil, or advance the auger until it is flush with the interval mark at ground level.
- Record weight of hammer, length of slide, blow counts, and geologic soil data for all samples collected with a core sampler in the field logbook as outlined in HGL SOP

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300.04: *Field Logbook Use and Maintenance*. This information may also be entered on Attachment 2, Surface and Shallow Soil Sampling Log.

- When the core sampler liner or auger has been advanced to the total depth of the required sample, remove it from the bottom of the hole.
- Immediately remove the liner from the core sampler and transfer the sample into a container or stainless steel bowl appropriate to the analysis being performed and then composite and homogenize it in accordance with HGL SOP 403.03: *Soil or Sediment Sample Compositing*. For VOC analysis follow the sample procedures outlined in HGL SOP 403.01: *VOC Soil Sample Collection*.
- Label the sample container and place it in a cooler chilled to 4°C . Complete the chain of custody record and pack it in the sample cooler.
- Material removed to collect the samples is returned to the boreholes and pits. Excess soil sample media IDW should be managed in accordance with the project-specific planning documents.
- Decontaminate all sampling nondedicated equipment following HGL SOP 411.02: *Sampling Equipment Cleaning and Decontamination*.

#### **4.8 ABANDONMENT PROCEDURES**

Abandon boreholes and fill them to grade with the material removed for sampling, if approved, or clean fill.

### **5.0 DOCUMENTATION**

Record applicable sampling information in the field logbook as outlined in HGL SOP 300.04: *Field Logbook Use and Maintenance*. This information can also be entered on Attachment 2, Surface and Shallow Soil Sampling Log.

The project manager or an approved designee checks all field sheets and field logbooks used to record information during sampling for completeness and accuracy as soon as possible after the sampling event. Any discrepancies are noted, and the documents are returned to the originator for correction. The reviewer acknowledges that these review comments have been incorporated by signing and dating the “checked by” and “date” blanks on the field sheets and at the applicable places in the logbook.

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## 6.0 REVISION HISTORY

Revision 0	July 2010	Initial Release
Revision 1	July 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	February 2018	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 3	June 24, 2020	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting, which included changing the SOP number from 2.13 to 403.06.

## ATTACHMENTS

Attachment 1 – Example of Hand Auger and Core Sampler  
Attachment 2 – Surface and Shallow Soil Sampling Log

**ATTACHMENT 1**  
**EXAMPLE OF HAND AUGER AND CORE SAMPLER**

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www.ams-samplers.com



*The world's finest  
sampling equipment.*

## Basic Soil Sampling Kit - 5/8" Threaded

Technical Data Sheet • page 1 of 1

### DESCRIPTION:

Hand auger kit includes a Standard type Regular, Mud and Sand Auger plus an AMS Core Sampler\* with slide hammer. Included accessories are three 4 foot (1.2m) extensions, cross handle, cleaning brush, 2 crescent wrenches and slip wrench all contained in an AMS Deluxe storage and transport case. Two sizes of kit are available, 3 1/4 inch (8.3 cm) augers with 2 inch (5.1 cm) Core Sampler and 2 1/4 inch (5.7 cm) augers with 1 1/2" Core Sampler. Quick connect is not available with this kit.

### APPLICATION:

Use of the augers for accessing the sampling point at depths of up to about 12 feet (3.6 m) with the supplied extensions and AMS slide hammer. The sample may be collected within a removable retaining cylinder (liner). Plastic end caps are included.

### FEATURES

AMS Soil augers are designed to rapidly remove soils of all types, using the specially designed bits on the Regular, Mud, and Sand models. The auger tips are tungsten carbide hard surfaced and heat treated before sharpening. The core sampler features a heat treated coring tip on the cylinder and a threaded end cap. All attachment couplings are 5/8 NC threaded.

### BENEFITS

For your convenience, all the items necessary for accessing a sampling point and then taking a sample are included. AMS soil buckets are the most efficient available in terms of effort required and speed. The AMS Core Sampler allows immediate core examination or a sample may be collected in a retaining cylinder for later use.

### USE:

Assemble the chosen soil auger with an extension and cross handle. Place at the desired angle on the soil surface and turn three revolutions, or until full. Lift carefully from the hole and empty from the bail by tapping the cross handle on the ground. Repeat until the sampling depth is reached. Assemble core sampler to an extension(s) and slide hammer. Place in the hole and mark the extension six inches (5.1 m) above the soil surface. Use the slide hammer to drive in the the sampler to the mark and carefully remove. Disassemble, remove the liner and place the cap on each end.

### HELPFUL HINTS:

Use plumbers wick on 5/8 inch male threads used with Slide Hammer to help threads stay tight. Keep all fittings and samplers clean, dry and free of dirt or Mud. You can clean tooling with soapy water. Always dry to prevent rusting. Use a wire brush on male threads. Use vegetable oil on tools to prevent fittings locking up and rusting. When using augers, use rubber O-rings on male 5/8 inch thread to help take apart.

### SPECIFICATIONS:

AMS Soil Auger Kits are manufactured by AMS from all USA made materials. See separate AMS Technical Data Sheets for details on the Regular, Mud, Sand & Soil Augers, Core Sampler, Extensions, Cross Handles, Slide

Hammer, and Liners. Crescent wrenches are made from chrome plated forged steel. The cleaning brush is made with nylon bristles, with a twisted wire handle. The AMS Deluxe Case is molded from glass reinforced plastic with a lid gasket and lockable hasps.

### Kit Composed of the Following Items

Item	Size	Part #	Size	Part#
1- Regular Auger	3 1/4"	400.06	2 1/4"	400.08
1- Mud Auger	3 1/4"	400.18	2 1/4"	400.20
1- Sand Auger	3 1/4"	400.40	2 1/4"	400.42
1- Cross Handle		406.04		406.04
3- Thrd. Extensions	4'	408.03	4'	408.03
1- Core Sampler*	2" x 6"	404.10	1 1/2" x 6	404.38
* w/slip wrench, liner & caps				
1- Slide Hammer		400.99		400.99
1-AMS Nylon Brush	2"	430.07	1 1/2"	430.11
2- Crescent Wrenches			421.10	
1- Slip Wrench		421.29		421.29
1-AMS Deluxe Case		430.01		430.01
* Patent Pending, USA & Foreign				

### ANCILLARY ITEMS:

AMS Extensions, Liners, End Caps, End Cap Inserts, Sieves, Soil Color Charts, and Sample Containers.

### Basic Soil Sampling Kit



### Basic Soil Sampling Kit

Size	Basic Kit Regular
2 1/4"	209.53
3 1/4"	209.51

Sampling Equipment  
PowerProbe  
Well Management  
Pest Control  
PowerCore

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**ATTACHMENT 2**  
**SURFACE AND SHALLOW SOIL SAMPLING LOG**

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# Surface and Shallow Soil Sampling Log

Records Management Data

Project Number	Project Name	Page _____ of _____
----------------	--------------	---------------------

<b>General Info</b>	Location		
	Surface Elevation ft.	Date Started	Date Completed
	Field Investigator		C of Cr
	Sampling Excavation Method	Sampling Method	
	Depth of Excavation ft.	Depth Water First Encountered ft.	Backfill Material

<b>Sampling Info</b>	<b>Sample Number</b>	<b>Depth (ft)</b>	<b>Lithologic Description<sup>1</sup></b>	<b>Sample Container</b>	<b>Analyses Requested</b>

<b>Plan View</b>		<b>Legend</b>
		Soil Sampling Location

Recorded By:	Date	Checked By:	Date:
--------------	------	-------------	-------


<sup>1</sup> Include such data as OVM, pH, blow counts, or other physical reading observations.

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**SOP 403.07, SIB Project Area, PHSS  
(Source: Geologic Borehole Logging)**

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	<b>STANDARD OPERATING PROCEDURE</b>	
	Approved by: Dick, Jeff	Digitally signed by Dick, Jeff Date: 2019.11.24 13:42:59 -05'00' Corporate Quality Manager
<b>Geologic Borehole Logging</b>	<b>SOP No.: 403.07 (formerly 2.14)</b>	
	<b>SOP Category: Environmental Services</b>	
	<b>Revision No.: 2</b>	
	<b>Revision Date: November 20, 2019</b>	
	<b>Review Date: November 2021</b>	

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) defines the methodology for conducting lithologic logging of cores, cuttings, split-spoon samples, and subsurface samples collected during field operations at sites where environmental investigations are performed by HGL.

## 2.0 SCOPE AND APPLICATIONS

The installation of monitoring wells, piezometers, and boreholes is a standard practice at many sites requiring environmental investigations. Following the guidelines presented in this SOP will help ensure that pertinent data is collected so that all borehole logs made while installing these devices at a site can be standardized to create a consistent, uniform database from which interpretive conclusions can be made with minimal decision error. A borehole log provides lithologic descriptions to characterize the physical subsurface and the geologic and hydrologic processes operating at the site. A properly prepared borehole log serves as an essential tool for evaluating and correlating these processes.

This SOP provides guidance for routine field operations on environmental projects, and was derived from *A Compendium of Superfund Field Operations Methods*, U.S. Environmental Protection Agency (EPA) (EPA/540/P-87/001 [Office of Solid Waste and Emergency Response {OSWER Directive} 9355.0-14]); and other industry standards.

## 3.0 GENERAL REQUIREMENTS

All work will be performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

## 4.0 PROCEDURES

### 4.1 INTRODUCTION

Boreholes should be logged by a trained geologist, or other earth scientist under the supervision of a geologist. Large-scale inferences such as vertical and horizontal extent of strata, facies changes, attitude of bedding or layering, structural features (faults, folds, fractures, dikes, etc.), location of the water table, lithologic characterizations, and the extent of subsurface contamination are made from small-scale observations recorded on the borehole log. These observations include bedding, grain

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size, degree of sorting, shape of grains, color, hardness, organic vapor levels, and other observable physical characteristics including visible evidence of contamination.

Logging should document both general and specific lithologic information about the borehole. In all cases, the lithologic log should be identified with the following:

- Specific site number,
- Well/boring number,
- Drilling method,
- Location,
- Date of drilling,
- Individual logger (geologist),
- Drilling contractor,
- Significant organic vapor reading,
- Visible evidence of contamination, such as staining or odor,
- Depth to water first encountered,
- Final depth of water level,
- Well/boring elevation (if data is available),
- Total depth in feet,
- Graphic log, and,
- Lithologic description.

Lithologic descriptions for unconsolidated materials often use the Unified Soil Classification System (USCS) or standard geologic field description methods (Compton, 1962).

Lithologic descriptions of unconsolidated material should contain the following characteristics when possible:

- Soil or formation name,
- Gradation degree of sorting,
- Principal constituent,
- Specific descriptors for principal constituents (for example, plasticity, grain size, and shape),
- Firmness/hardness,
- Minor constituents,
- Moisture content,
- Color,
- Particle morphology, and

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- Other descriptors (such as, visual evidence of contamination, specific monitoring equipment readings including photoionization detector [PID]/organic vapor analyzer [OVA] readings).

## **4.2 CLASSIFICATION SYSTEM**

The following subsections describe in detail the parameters and descriptive terminology used to classify each sample for the borehole log.

### **4.2.1 Soil or Formation Name**

The soil or formation name will include the major constituent(s) and may be preceded by a single-word modifier indicating the subordinate constituent. Percentages of each constituent will be used to classify the material without actually recording constituent percentage. The textural terms used to classify a soil are shown in Attachment 1, Triangular Diagram Showing Percentage of Sand, Silt, and Clay in Each Textural Class. If logging unconsolidated materials, a USCS symbol should be recorded. The USCS symbols are provided in Attachment 2, Unified Soil Classification System Table.

### **4.2.2 Gradation (Degree of Sorting)**

Size sorting describes the extent to which grain size is uniform. The comparison chart listed in Attachment 3, Comparison Chart for Estimating Degree of Sorting, is used to describe coarse-grained soils being logged from a borehole. The USCS describes soils in terms of grading, which is the opposite of sorting. For example, a poorly graded sand (USCS classification SP) is well sorted and has a predominant grain size, and a well graded gravel (USCS classification GW) is poorly sorted and has a wide distribution of grain sizes.

### **4.2.3 Principal Constituent**

Principal constituents recorded during borehole logging include an identification of the following unconsolidated material types in order of increasing grain size:

- Clay,
- Silt,
- Sand,
- Gravel,
- Cobbles, and
- Boulders.

If known, an identification of the potential source of the material should be made (such as alluvium, colluvium, artificial fill, or residual material).

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#### 4.2.4 Principal Constituent Descriptors

Additional descriptors for the principal material constituents may be added to the log to further delineate or accurately record subtle changes in the lithologic structure. Modifiers such as grain size, shape, and plasticity of materials (high, medium, and low plasticity). (Note: Plasticity is the property of permanently changing shape without movement on any visible fractures.)

#### 4.2.5 Consistency/Density/Rock Hardness

The characteristics of unconsolidated material are often determined by hand or the Standard Penetration Test (SPT).

Hand testing of unconsolidated material involves pressing the thumb into the undisturbed material to determine its consistency based on the following descriptors:

<u>Depth of Thumb Imprint</u>	<u>Cohesive Consistency (Clay)</u>
Greater than 1 inch	Very soft
Approximately 1 inch	Soft
Approximately ¼ inch	Firm
Thumb will not indent soil but readily indented by fingernail	Hard
Thumb nail will not indent soil	Very hard

The SPT involves driving a split-spoon sampler into the material by dropping a 140-pound weight from a height of 30 inches. The resistance of the material is reported in the number of blows of the weight required to drive the spoon one foot and translates into the following descriptors:

<u>Number of Blows/Foot</u>	<u>Cohesive Consistency (Clay)</u>
0–2	Very soft
2–4	Soft
4–8	Medium
8–15	Stiff
15–30	Very stiff
30+	Hard
<u>Number of Blows/Foot</u>	<u>Cohesive Consistency (Gravel)</u>
0–4	Very loose
4–10	Loose
10–30	Medium dense
30–50	Dense
50+	Very Dense

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#### Number of Blows/Foot

<20  
20–30  
30–50  
50–80  
80+

#### Rock Hardness

Weathered  
Firm  
Medium Hard  
Hard  
Very Hard

### **4.2.6 Minor Constituents**

Constituents not previously described in the principal constituent description may be described as a percentage or by weight. Typically, modifiers for minor constituents conform to the following standards:

- No modifier < 5 percent,
- Slightly 5 to 12 percent,
- Moderately (add ‘-y’ or ‘-ey’ such as silty clay) 12 to 40 percent, or
- Very 40 to 50%.

### **4.2.7 Moisture Content**

The terms used to describe the relative moisture content of a field soil sample are as follows:

- Dry – The sample is completely without moisture. Dry, silty sands, for example, will produce suspended particles when dropped by hand.
- Damp – Samples containing a very slight amount of water.
- Moist – Soils in this range are near the maximum water content for their maximum compactibility or density. Moist fine-grained soils with a water content greater than their plastic limit will form a ball when compressed in the hand.
- Wet – The soil samples are wet enough to produce free water upon shaking but still contain unoccupied air voids. Fine-grained soils close to the liquid limit would be termed wet.
- Saturated – Soils with no air voids. Samples placed in sample jars or bags will probably have standing water after a short period of time.

### **4.2.8 Plasticity**

The plasticity of fine-grained soils is recorded on the borehole log. A fine-grained soil can be non-plastic or have low, medium, or high plasticity. The plasticity is measured by the ability to roll the material into a 1/8-inch-thick thread based on the following descriptors:

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- Non-plastic – The thread cannot be rolled at any water content.
- Low plasticity – The thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.
- Medium plasticity - The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
- High plasticity – It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier the plastic limit.

#### **4.2.9 Color**

The color of soil and associated materials will be recorded on the borehole log. Color descriptors should include but are not limited to the following descriptors: black, gray-black, brown, olive, mottled, and streaked. A Munsell Soil Color Chart should be used to provide general logging guidance, but specific use is not necessary for adequately describing lithology.

#### **4.2.10 Particle Morphology**

The key elements of particle morphology are roundness and sphericity. Roundness is a measure of the curvature of grain corners. Sphericity is a measure of how equal the three axial lengths (x, y, z) of an object are. Determination of both properties is facilitated by the use of a hand lens. Estimate grain roundness and sphericity in coarse-grained soils by using an American Geological Institute (AGI) data sheet (Attachment 4).

#### **4.2.11 Other Descriptors**

Field screening data collected during the drilling process may help further characterize site conditions during subsurface investigations. Readings from on-site monitoring equipment such as PIDs, flame ionization detectors (FIDs), or OVAs should be recorded at each sample interval. Other useful information includes the organic content and the presence or absence of waste material in samples.

#### **4.2.12 Particle Size Distribution**

An estimate of particle sorting by grain size is often useful for borehole logging purposes. Precise estimates of percent composition of the sample are not necessary.

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### USCS Grain Size Categories

Exact Size Limits	Approximate Inch Equivalents	Name of Loose Aggregate
>256 mm	>10 in.	Boulder gravel
64–256 mm	2.5–10 in.	Cobble gravel
32–64 mm	1.2–2.5 in.	Very coarse pebble gravel
16–32 mm	0.6–1.2 in.	Coarse pebble gravel
8–16 mm	0.3–0.6 in.	Medium pebble gravel
4–8 mm	0.15–0.3 in.	Fine pebble gravel
2–4 mm	0.08–0.15 in.	Granule (or very fine pebble) gravel
1–2 mm	0.04–0.08 in.	Very coarse sand
1/2–1 mm	0.02–0.04 in.	Coarse sand
1/4–1/2 mm	0.01–0.02 in.	Medium sand
1/8–1/4 mm	0.005–0.01 in.	Fine sand
1/16–1/8 mm	0.002–0.005 in.	Very fine sand
1/256–1/16 mm	0.00015–0.002 in.	Silt
<1/256 mm	<0.00015 in.	Clay (clay-size materials)

mm = millimeters

Source: Wentworth Scale; Compton 1962

The Comparison Chart for Estimating Percentage Composition (Attachment 5) can be used to estimate the percentage of various grain sizes present in a sample. However, visual estimates usually provide sufficient information for characterizing site lithology.

### 4.3 BOREHOLE LOGS

Record data collected during exploratory boring soil logging in the field logbook and on Attachment 6, Borehole Log. Use this log on all applicable field drilling and subsurface sampling operations.

Geologic correlation and aquifer properties prediction are dependent on good exploratory boring sample descriptions. Rotary drilling with fluids is generally unacceptable since the drilling fluids may potentially contaminate the aquifer under investigation and provide inaccurate water levels. High quality borehole data are generally acquired with a direct-push acetate-lined sampler, a split-spoon sampler, or a sonic core barrel. This method of sampling provides detailed logging because the samples collected are undisturbed. The lithofacies interpreted from air-rotary or auger cuttings logs may lack the accuracy necessary for detailed correlation. Where possible, techniques such as geophysical borehole logging will be used to supplement cuttings descriptions. Note on the log any geologic description determined from borehole cuttings. The cuttings are often mixed over the entire length of the boring.

In bedrock formations, cuttings may be acquired from a reverse circulation, air rotary, or dual-wall rotary boring. These cuttings do not provide information on the in situ properties of the materials, but do provide adequate sample description information.

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In summary, close sample spacing or continuous sampling in a boring provide the best material for descriptive geology. Use traditional geologic terminology and supplement with the USCS descriptive system when appropriate. Provide sufficient data on layering and other sedimentary structures and undisturbed textures. Sample numbers, depths, and analytes should be included in each description. The applicable field methods described by Compton (1962) and AGI (1982) are recommended. These methods are fully referenced in Section 5.0.

#### **4.4 REVIEW**

Personnel conducting borehole logging of soil will record field data on Attachment 6, Borehole Log, and will record a chronological summary in the project logbook. The applicable methods outlined in this procedure shall be used to record the data on this log. The personnel conducting these operations will sign and date the “logged by” and “date” blanks on Attachment 6, Borehole Log.

The Project Manager or designee shall check all field generated data and Attachment 6, Borehole Log, for completeness and accuracy. Any discrepancies will be noted, and the logs will be returned to the originator for correction. The reviewer will acknowledge that corrections have been incorporated by signing and dating the “reviewed by” and “date” blanks on Attachment 6, Borehole Log.

#### **5.0 REFERENCES**

American Geological Institute (AGI), 1982. AGI Data Sheets. Falls Church, Virginia.

ASTM International, 2009. ASTM D2488-09a: *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*. West Conshohocken, Pennsylvania.

Compton, Robert R., 1962. *Manual of Field Geology*. John Wiley and Sons, Inc. New York, New York.

Munsell, 1988. Munsell Soil Color Charts. Macbeth Division, Kollmorgen Instruments Corporation, Baltimore, Maryland.

#### **6.0 REVISION HISTORY**

Revision 0	December 2010	Initial Release
Revision 1	July 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	November 20, 2019	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.



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## **ATTACHMENTS**

Attachment 1 – Triangular Diagram Showing Percentage of Sand, Silt and Clay in Each Textural Class

Attachment 2 – Unified Soil Classification System Table

Attachment 3 – Comparison Chart for Estimating Degree of Sorting

Attachment 4 – Comparison Chart for Estimating Roundness and Sphericity

Attachment 5 – Comparison Chart for Estimating Percentage Composition

Attachment 6 – Borehole Log

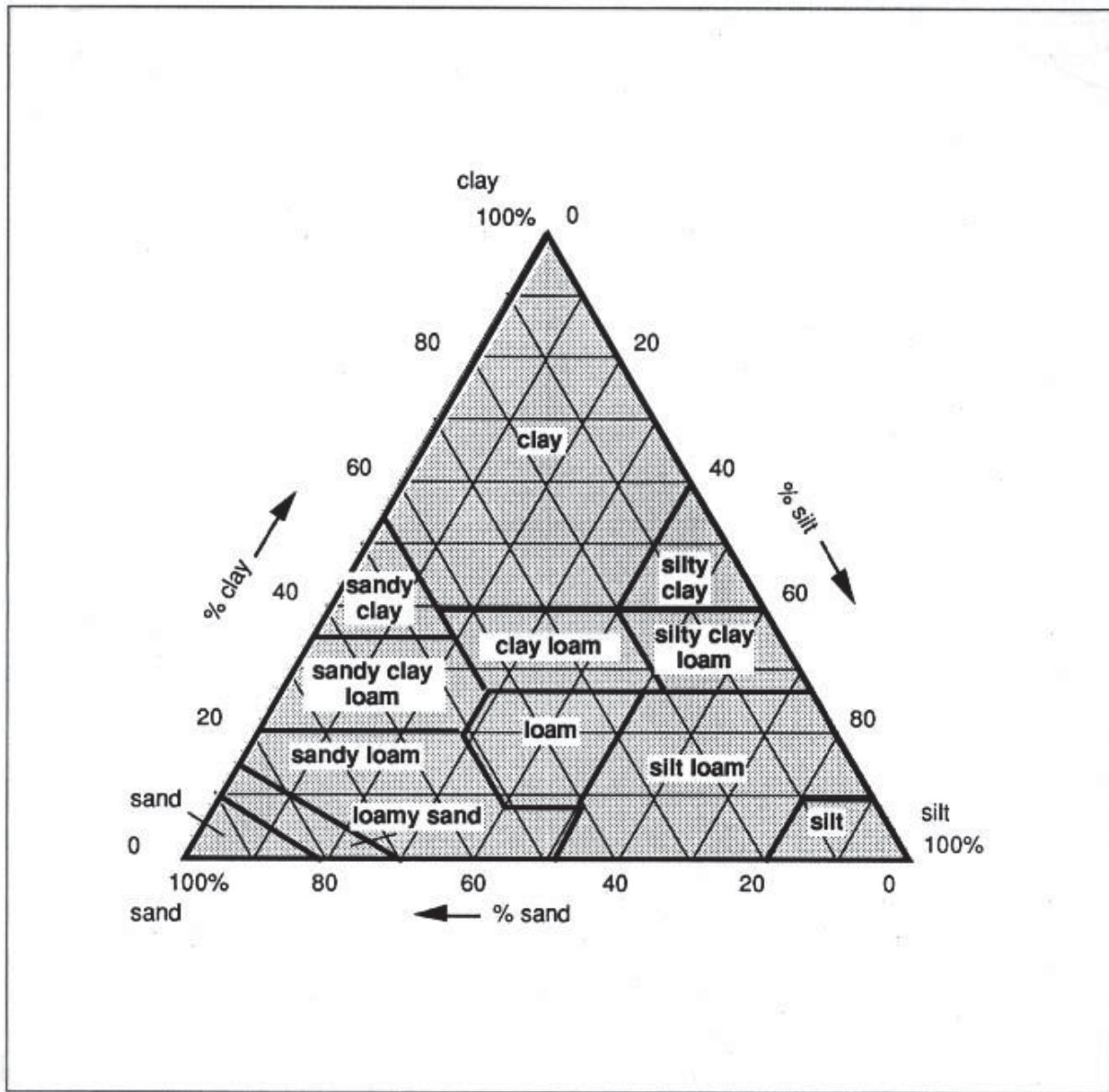
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**ATTACHMENT 1**

**TRIANGULAR DIAGRAM SHOWING PERCENTAGE OF SAND, SILT  
AND CLAY IN EACH TEXTURAL CLASS**

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**Attachment 1**  
**Triangular Diagram Showing Percentage of Sand, Silt and**  
**Clay in Each Textural Class**



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**ATTACHMENT 2**
















**UNIFIED SOIL CLASSIFICATION SYSTEM TABLE**

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## Attachment 2

### Unified Soil Classification System Table

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART			LABORATORY CLASSIFICATION CRITERIA	
<b>COARSE-GRAINED SOILS</b> (more than 50% of material is larger than No. 200 sieve size.)				
<b>GRAVELS</b> More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)			
		GW	Well-graded gravels, gravel-sand mixtures, little or no fines	
		GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines	
	Gravels with fines (More than 12% fines)			
		GM	Silty gravels, gravel-sand-silt mixtures	
		GC	Clayey gravels, gravel-sand-clay mixtures	
<b>SANDS</b> 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)			
		SW	Well-graded sands, gravelly sands, little or no fines	
		SP	Poorly graded sands, gravelly sands, little or no fines	
	Sands with fines (More than 12% fines)			
		SM	Silty sands, sand-silt mixtures	
		SC	Clayey sands, sand-clay mixtures	
<b>FINE-GRAINED SOILS</b> (50% or more of material is smaller than No. 200 sieve size.)				
<b>SILTS AND CLAYS</b> Liquid limit less than 50%		ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity	
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		OL	Organic silts and organic silty clays of low plasticity	
<b>SILTS AND CLAYS</b> Liquid limit 50% or greater		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
		CH	Inorganic clays of high plasticity, fat clays	
		OH	Organic clays of medium to high plasticity, organic silts	
<b>HIGHLY ORGANIC SOILS</b>		PT	Peat and other highly organic soils	

$C_u = \frac{D_{60}}{D_{10}} \text{ greater than } 4; C_c = \frac{D_{30}}{D_{10} \times D_{60}} \text{ between } 1 \text{ and } 3$	
GW	
GP Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4
GC	Atterberg limits above "A" line with P.I. greater than 7
Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols	
$C_u = \frac{D_{60}}{D_{10}} \text{ greater than } 4; C_c = \frac{D_{30}}{D_{10} \times D_{60}} \text{ between } 1 \text{ and } 3$	
SW	
SP Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4
SC	Atterberg limits above "A" line with P.I. greater than 7
Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

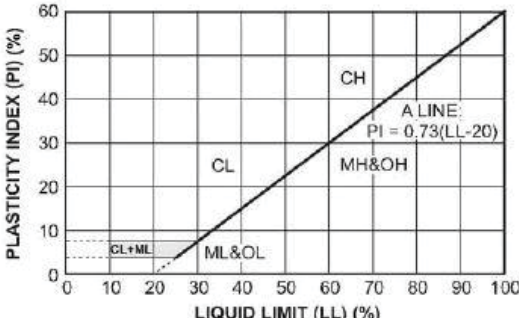
Less than 5 percent ..... GW, GP, SW, SP

More than 12 percent ..... GM, GC, SM, SC

5 to 12 percent ..... Borderline cases requiring dual symbols

**PLASTICITY CHART**



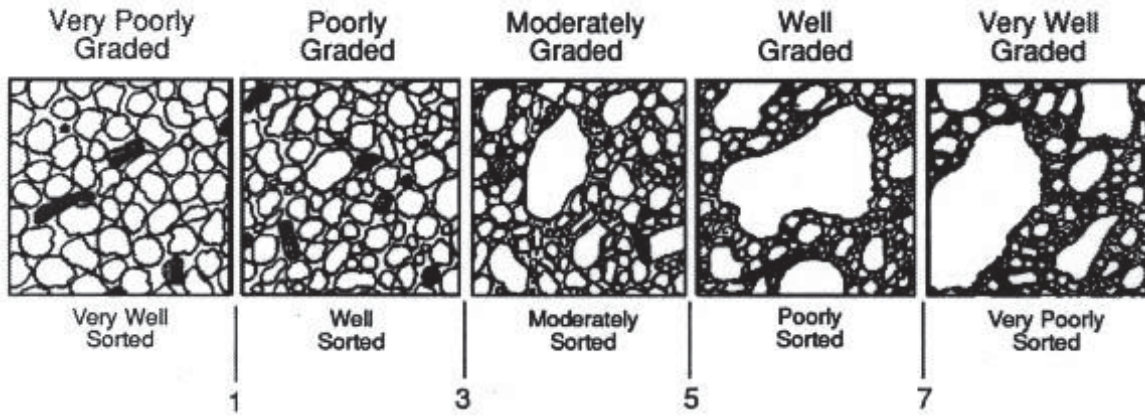
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### **ATTACHMENT 3**

## **COMPARISON CHART FOR ESTIMATING DEGREE OF SORTING**

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**Attachment 3**  
**Comparison Chart for Estimating Degree of Sorting**



Terms for degrees of sorting. The numbers indicate the number of size-classes included by the bulk (80 percent) of the material. The drawings represent sandstones as seen with a hand lens. Silt and clay-size materials are shown diagrammatically by the fine stipple.

**Reference:** Compton, R.R. 1962. *Manual of Geology*. John Wiley & Sons, Inc. New York, N p. 214

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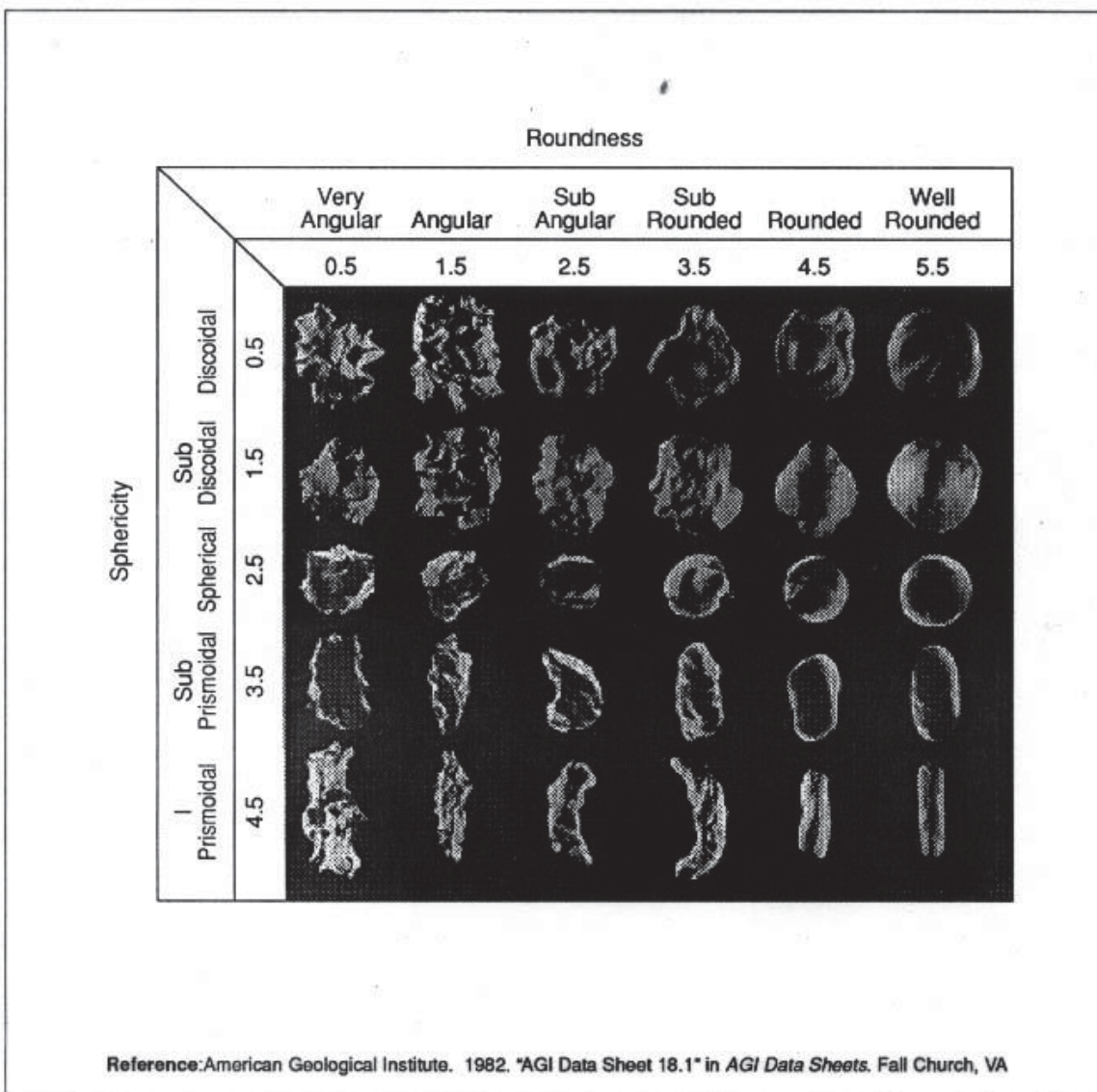
**ATTACHMENT 4**

**COMPARISON CHART FOR ESTIMATING  
ROUNDNESS AND SPHERICITY**

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# **Attachment 4** **Comparison Chart for Estimating Roundness and Sphericity**



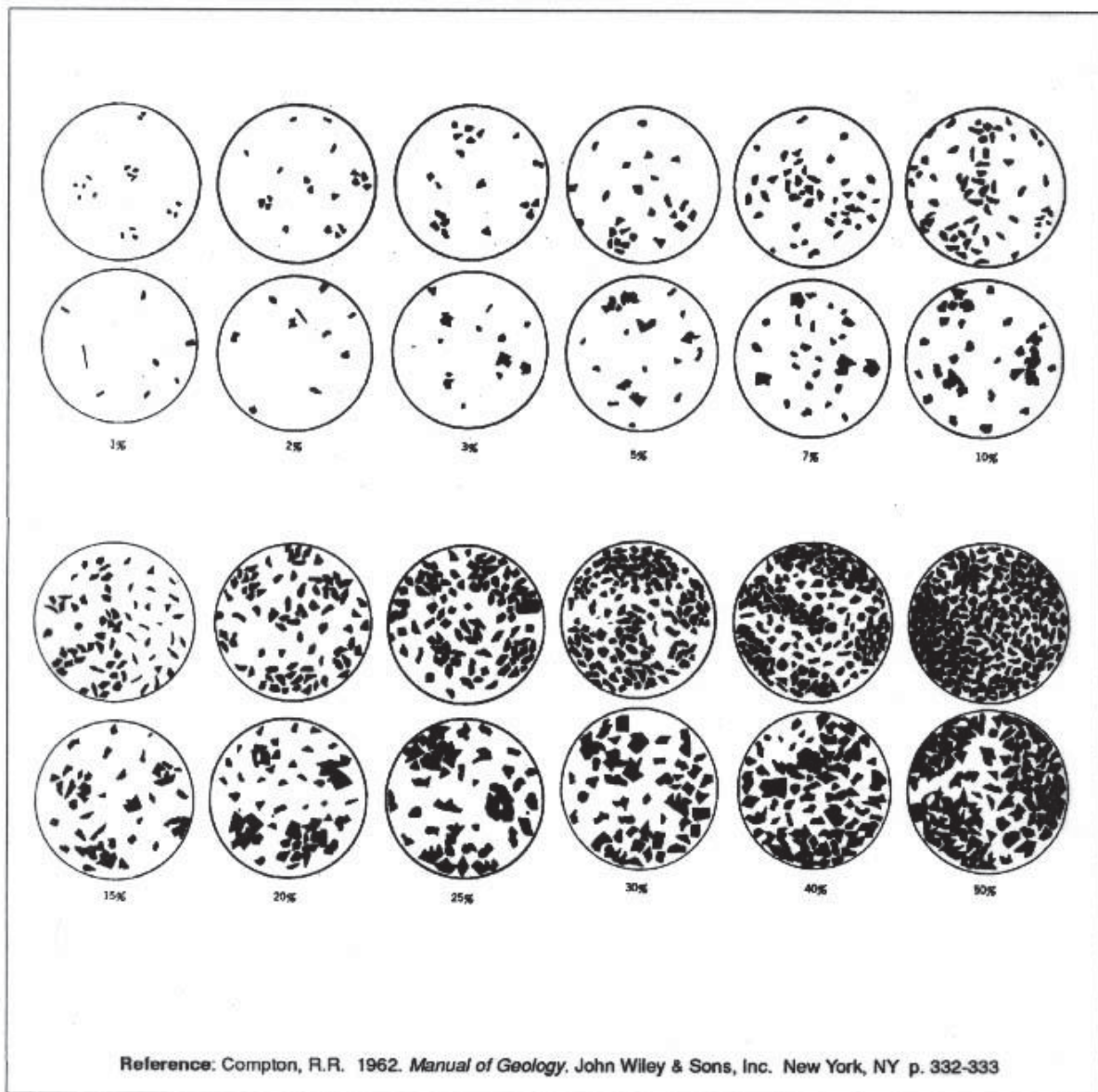
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**ATTACHMENT 5**

**COMPARISON CHART FOR ESTIMATING  
PERCENTAGE COMPOSITION**

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**Attachment 5**  
**Comparison Chart for Estimating Percentage Composition**



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**ATTACHMENT 6**

**BOREHOLE LOG**

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## Attachment 6 Borehole Log



### BORING LOG


Borehole ID: \_\_\_\_\_  
Sheet \_\_\_\_\_ of \_\_\_\_\_

Project Name		Project Number		Site ID	Location			
Drilling Company		Driller		Ground Elevation	Total Drilled Depth			
Drilling Equipment	Drilling Method	Borehole Diameter	Date/Time Drilling Started		Date/Time Total Depth Reached			
Type of Sampling Device			Water Level (bgs)					
			First		Final			
Sample Hammer			Hydrogeologist		Checked by/Date			
Type _____ Driving Wt. _____ Drop _____								
Location Description (include sketch in field logbook)								
Depth	Interval	Recovery	Blow Counts	Description <small>(Include lithology, grain size, sorting, angularity, Munsell color name &amp; notation, mineralogy, bedding, plasticity, density, consistency, etc., as applicable)</small>	USCS Symbol	Lithology	Water Content	Remarks <small>(Include all sample types &amp; depth, odor, organic vapor measurements, etc.)</small>



**SOP 403.08, SIB Project Area, PHSS**  
**(Source: Sediment Sampling)**

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	<b>STANDARD OPERATING PROCEDURE</b>	
	Approved by: <b>Dick, Jeff</b>	Digitally signed by Dick, Jeff Date: 2020.03.24 18:37:26 -04'00' Corporate Quality Manager
<b>Sediment Sampling</b>	<b>SOP No.: 403.08 (formerly 2.15)</b>	
	<b>SOP Category: Environmental Services</b>	
	<b>Revision No.: 2</b>	
	<b>Revision Date: March 25, 2020</b>	
	<b>Review Date: March 2022</b>	

## 1.0 PURPOSE

This standard operating procedure (SOP) establishes the guidelines for sediment sampling using a variety of sampling devices. Methods for preventing sample and equipment cross-contamination are included. Proper sediment sampling ensures that any evaluations of sediment contamination are based on actual contaminant levels and are not based on improper sampling techniques.

This SOP provides guidance for routine field operations on environmental projects. Site-specific deviations from the methods presented herein must be approved by the HGL project manager.

## 2.0 SCOPE AND APPLICATIONS

Field personnel collecting sediment samples are responsible for performing the applicable tasks outlined in this procedure when conducting work related to environmental projects.

The project manager or an approved designee is responsible for checking all work performed and verifying that the work satisfies the applicable tasks required by this procedure. This verification will be accomplished by reviewing all documents and data produced during work performance.

## 3.0 GENERAL REQUIREMENTS

All work will be performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and documented in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

## 4.0 SAMPLING EQUIPMENT AND TECHNIQUES

Sediment samples may be obtained using on-shore or off-shore techniques. Sediment sampling equipment and techniques must be designed to minimize the risk of dilution or loss of material as the sample is moved through the water column. Sediment sampling devices are described below.

### 4.1 DIP SAMPLERS

A dip sampler consists of a pole with a jar or scoop attached. The pole may be made of bamboo, wood, Teflon<sup>®</sup>, or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is attached by a clamp.

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The dip sampler is operated by submerging the jar or scoop and pulling it through the sediments to be sampled. The samples retrieved are then transferred into the appropriate sample container after decanting the liquid. Further decanting can occur while the sample is present in the sample jar. Avoid contact with sampler's gloves. Transferring the sample may require the use of a stainless steel or Teflon<sup>®</sup> spoon/spatula.

## **4.2 HAND-OPERATED CORE SAMPLERS**

Hand-operated sediment core samplers are used to obtain sediment samples in shallow water (less than 3 feet). These samplers operate in a manner similar to soil core samplers. However, because of the saturated conditions of most sediments, provisions must be made to retain the sample within the core. Core samplers are generally constructed of a rigid metal outer tube into which a 2-inch plastic core sleeve fits with minimum clearance. The cutting edge of the core sampler has a recessed lip on which the plastic sleeve rests and that can accommodate a core retainer. This retainer is oriented such that when the sampler is pressed into the sediment, the core is free to move past the retainer. Due to construction of the retainer, the core will not fall through the retainer upon removal of the sampler from the sediment. Some core samplers are also equipped with a butterfly valve below the core barrel that helps retain the material when the sampler is removed from the sediment.

After the sampler has been removed from the sediment, the plastic sleeve is removed. The sediment is removed from the sleeve and placed in the appropriate sample container. Chlorinated organics will not be collected using core samplers because core sleeves and retainers are generally made of plastic. The hand-operated core sampler will not be useful for obtaining samples of gravelly, stony, or consolidated sediments. Examples of hand-operated core samplers are referenced in Attachment 1.

## **4.3 GRAVITY CORE SAMPLERS**

Gravity core samplers are used to obtain sediment samples in water bodies or lagoons with depths greater than 3 to 5 feet. These types of samplers can be used for collecting 1- to 2-foot cores of surface sediments at depths of up to 100 feet beneath the water surface.

As with all core-type samplers, gravity core samplers are not suitable for obtaining samples of coarse, gravelly, stony, or consolidated deposits. They are, however, useful for fine-grained inorganic sediment sampling.

The gravity core sampler operates in a manner similar to the hand-operated core in that a 2-inch plastic sleeve fits within a metal core housing fitted with a cutting edge. Plastic nests are used to retain the core within the plastic sleeve. An opening exists above the core sleeve to allow free flow of water into and through the core as it moves vertically downward to the sediment. The sampler has a field personnel-operated, messenger-activated valve assembly that seals the opening above the plastic sleeve following sediment penetration. This valve is activated by the messenger, creating a partial vacuum to assist in sample retention during retrieval.

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Samples are obtained by allowing the sampler, which is attached to approximately 100 feet of stainless steel aircraft cable, to drop to the benthic deposits. The weight of the sampler drives the core into the sediment to varying depths depending on the characteristics of the sediments. The messenger is then dropped by field personnel on the taut aircraft cable to seal the opening above the plastic sleeve. The sampler is then carefully retrieved.

Upon retrieval of the sampler, the plastic core sleeve is removed and the sample is placed in the appropriate sample container. Care should be exercised in labeling to properly identify sample orientation. Examples of gravity core samplers are referenced in Attachment 2.

#### **4.4 DREDGES**

Dredges are generally used to sample sediments that cannot easily be obtained using coring devices or when large quantities of materials are required. Various dredge designs are available for sampling in deep or turbulent waters and for obtaining samples from gravelly, stony, or dense deposits.

Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a messenger. Dredges are commonly quite heavy and may require use of a winch and crane assembly for sample retrieval.

Upon retrieval of the dredge, the sample can either be sieved or transferred directly to a sample container for labeling and storage. Examples of dredge types that could be used for sampling include Ponar, Petersen, and Ekman dredges, which are referenced in Attachment 3.

#### **4.5 HAND AUGERS**

Sediment samples may be collected using a hand auger. When using a hand auger, provisions must be made to ensure that sediment samples remain in the auger. Hand augers are best utilized when sampling non-subaqueous sediments. Additional information on hand augers can be found in SOP 403.06: *Surface and Shallow Depth Soil Sampling*.

### **5.0 PROCEDURES**

#### **5.1 SAMPLING SEDIMENT WITH NO OVERLYING SURFACE WATER**

Sediment samples obtained from areas with no overlying surface water will be collected in accordance with the following procedures:

- Record all data in the field logbooks in accordance with SOP 300.04: *Field Logbook Use and Maintenance*.

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- Insert a decontaminated Teflon® or stainless steel spoon, scoop, or trowel into the sediment to the desired depth and remove the collected sample, or rotate and push down a decontaminated hand auger into the sediment to the desired depth and remove the collected sample. A disposable scoop may be used for specified media and analytical parameters in accordance with the site-specific project plans.
- Collect samples for volatile organic compounds (VOC) analyses, if applicable, from the sampling device or from unmixed sediment placed into a stainless steel bowl in accordance with SOP 403.01: *VOC Soil Sample Collection*.
- Place the sample in a decontaminated stainless steel bowl. Stir the sample thoroughly (non-VOC samples only) with a decontaminated stainless steel spoon or spatula—or with a dedicated disposable scoop—to provide a homogeneous mixture before filling sampling containers.
- Follow the guidelines in the site-specific project plans and Quality Assurance Project Plan (QAPP) for aliquot size (mass), container type, storage conditions, and holding times. [Note: When sampling in coarse materials, such as gravel, discretion must be used to limit inclusion of large sediment particles. As the analysis of sediments performed by the laboratory is typically restricted to particles less than 2 millimeters in size, care must be taken to ensure that there is sufficient sample volume consisting of particles smaller than 2 millimeters. As a general rule, particles larger than 0.5 inch (12.7 millimeters) in size should be excluded unless a grain size analysis is planned.] Fill the appropriate sample containers as detailed in the site-specific project plans. Identify or label samples carefully and clearly, addressing all the categories or parameters.
- Label the sample containers and place the filled sample containers on ice immediately.
- Decontaminate the sampling equipment in accordance with SOP 411.02: *Sampling Equipment Cleaning and Decontamination*, after use and between sampling if dedicated disposable scoops are not used. Don new clean gloves before beginning sampling activities and at each sampling point.
- Complete all chain of custody documents and record information in the Field Sampling Report (Attachment 4) and the field logbook (see the project-specific QAPP for sample custody procedures).

## 5.2 SHALLOW STREAM SEDIMENT SAMPLING

Stream sediment sampling within shallow (less than 2 feet) water will be conducted in accordance with the following procedures. Note that if co-located surface water samples are being collected, the surface water sample should be collected first.

- Collect the sample in an area of sediment accumulation, such as the inside of stream meanders, quiet shallow areas, and low-velocity zones. Avoid areas of net erosion, such as high-velocity, turbulent flow zones.



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- If possible, collect the sample while remaining on the stream bank. If the sample cannot be obtained from the bank, enter the stream from a point downstream of the sediment sampling location. Consult the site health and safety plan before entering the river to avoid potential hazards. Collect the sediment sample by reaching into the stream with a decontaminated stainless steel spoon or Teflon® scoop and scooping a sample in an upstream direction. Attempt to minimize the loss of fine material. A disposable scoop may be used for specified media and analytical parameters, in accordance with the site-specific project plans.
- Collect samples for VOC analyses, if applicable, from the sampling device or from unmixed sediment placed into a stainless steel bowl in accordance with SOP 403.01: *VOC Soil Sample Collection*.
- Place sample in a stainless steel bowl and gently mix with a stainless steel spoon or dedicated disposable scoop (non-VOC samples only). Transfer the sediment samples to the appropriate sample containers using the stainless steel spoon or dedicated disposable scoop. Do not mix samples for volatile organic analyses.
- Follow the guidelines in the site-specific project plans and QAPP for aliquot size (mass), container type, storage conditions, and holding times. See note under Section 5.1 for sampling coarse materials. Fill the appropriate sample containers as detailed in the site-specific project plans. Identify or label samples carefully and clearly, addressing all the categories or parameters.
- Decontaminate the sampling equipment in accordance with SOP 411.02: *Sampling Equipment Cleaning and Decontamination*, after use and between sampling if dedicated disposable scoops are not used. Don new clean gloves before beginning sampling activities and at each sampling point.
- Complete all chain of custody documents and record information in the Field Sampling Report (Attachment 4) and the field logbook (see the project-specific QAPP for sample custody procedures).

### 5.3 SUBAQUEOUS SEDIMENT SAMPLING

Subaqueous sediment sampling from lakes, ponds, lagoons, and surface impoundments will consist of the following:

- Select the most appropriate sediment sampling device (as described in Section 4.0).
- Decontaminate all sampling equipment in accordance with SOP 411.02: *Sampling Equipment Cleaning and Decontamination*.
- If sampling from a boat equipped with an engine, attempt to collect the sample with the boat engine off or attempt to ensure that all exhaust fumes are directed away from the sample collection area until the sample has been collected.

<b>Sediment Sampling</b>	<b>SOP No.: 403.08 (formerly 2.15)</b>
	<b>SOP Category: Environmental Services</b>
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	<b>Review Date: March 2022</b>

- Lower the sampler at a controlled descent of approximately 1 foot per second until the sampler reaches the sediment surface, as indicated by a slackening of the cable. Release the weighted messenger, if applicable, to engage the closing mechanism of the dredge. Slowly retrieve the sampler and raise it at a controlled speed. When the sampler is at the water surface, attach a tag line(s) to steady and pull the sampler back into the boat. If large samplers are used, a motorized winch may be required for retrieval.
- Open and tie back any vent flaps on the sampler and carefully siphon off any overlying water, disposing of it over the side of the boat.
- Visually inspect the sample for acceptability (for example, determine if an undisturbed surface layer is evident, the overlying water is not excessively turbid, and adequate penetration is achieved). If the sample is not acceptable, discard it and collect another sample from an adjacent and upstream location.
- Carefully extrude the sediment from the sampler by slowly lifting on the winch cable and sliding the sample out the bottom of the sampler. If using core liners, remove the front face of the core liner to expose the side of the core.
- Visually inspect the side of the sample to identify any obvious stratification (such as different sediment types, sizes, or colors). If no patterns are evident, collect a sample from the surface and mid-core depth. During some investigations, it may be necessary to collect separate samples from the surface and mid-core depths. This may best be accomplished by gently scraping the side of the core with a decontaminated stainless steel scraper or knife. Scrape from the bottom to the top of the core only. If the sediment is unconsolidated, do not scrape.
- Remove the upper 2 centimeters of the sample using a decontaminated Teflon® or stainless steel scoop—or dedicated disposable scoop—and place it in the sample container. From an undisturbed area of the sample surface, scoop a 2-centimeter sample only if grain size analysis is required. After grain size analysis samples are collected, scrape off the upper sediment layer and discard it overboard. Collect samples from the mid-section of the sediment. Sediment must be removed with caution to avoid cross-contaminating the sample (that is, from exposure to engine exhaust, rust, or grease).
- Do not include nonrepresentative materials, such as twigs or debris, in the sample. Do not include sediments that have come into contact with the side of the sampler or core liner for analysis.
- Follow the guidelines in the site-specific project plans and QAPP for aliquot size (mass), container type, storage conditions, and holding times. Fill the appropriate sample containers as detailed in the site-specific project plans. Identify or label samples carefully and clearly, addressing all the categories or parameters;
- Decontaminate the sampling equipment in accordance with SOP 411.02: *Sampling Equipment Cleaning and Decontamination* after use and between sampling if dedicated

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disposable scoops are not used. Don new clean gloves before beginning sampling activities and at each sampling point.

- Complete all chain of custody documents and record information in the Field Sampling Report (Attachment 4) and the field logbook (see the project-specific QAPP for sample custody procedures).

## 6.0 RECORDS

Documentation generated as a result of this procedure is collected and maintained in accordance with requirements detailed in the project-specific planning documents. The field logbook will be completed in accordance with procedures listed in SOP 300.04: *Field Logbook Use and Maintenance*. A Field Sampling Report will be filled out for each sediment sample collected (Attachment 4).

## 7.0 REVISION HISTORY

Revision 0	December 2010	Initial Release
Revision 1	August 11, 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	February 25, 2020	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting, which included changing the SOP number from 2.15 to 403.08.

## ATTACHMENTS

Attachment 1 – Core Sampler  
Attachment 2 – Gravity Core Sampler  
Attachment 3 – Dredges  
Attachment 4 – Field Sampling Report

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**ATTACHMENT 1**  
**CORE SAMPLER**

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## CORE SAMPLER



AMS Core Sampler (<http://www.ams-samplers.com/hand-tooling/sludge-and-sediment-samplers/sludge-and-sediment-samplers/sludge-and-sediment-samplers.html>)

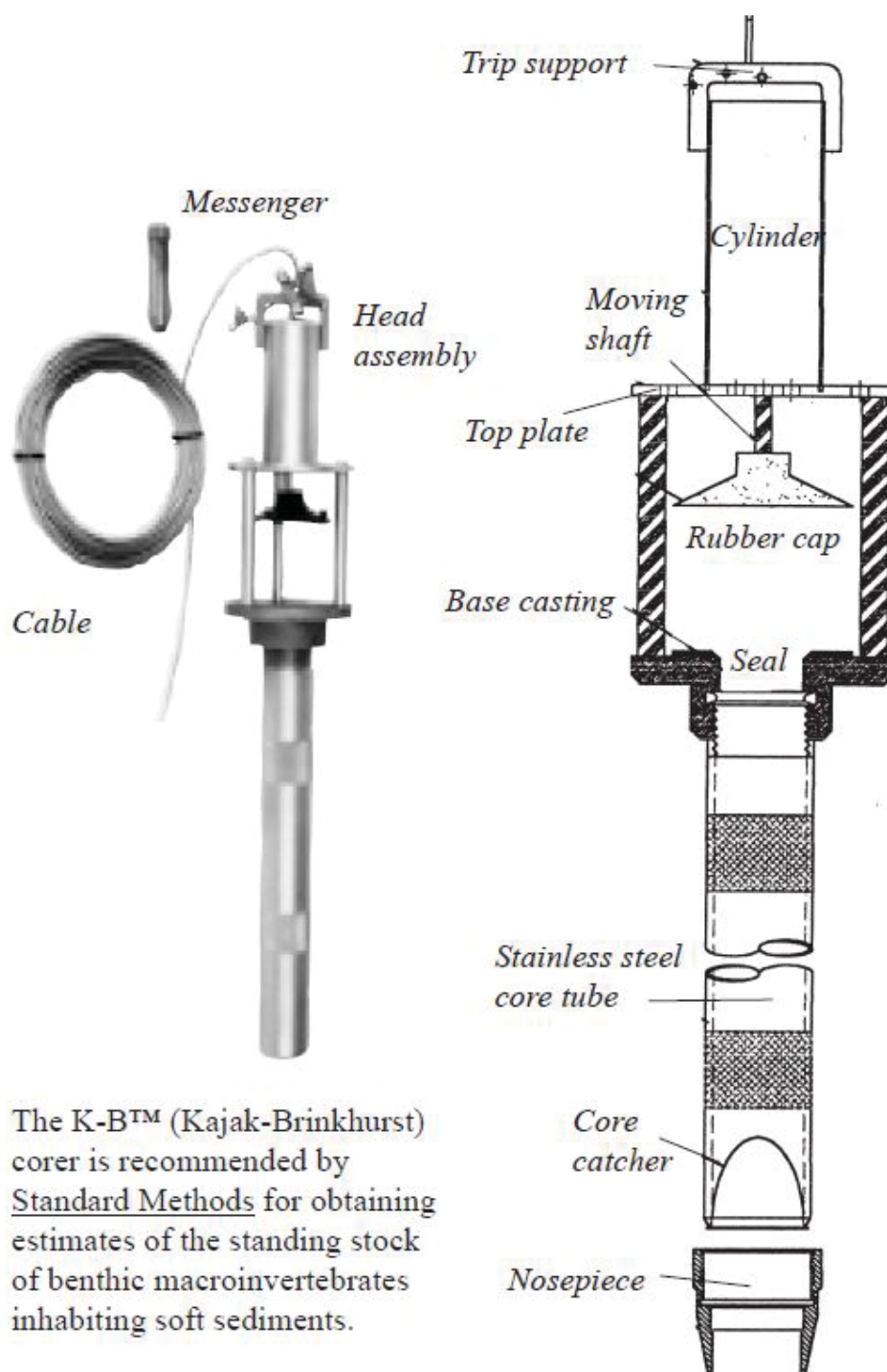
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**ATTACHMENT 2**  
**GRAVITY CORE SAMPLER**

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## K-B GRAVITY CORER



The K-B™ (Kajak-Brinkhurst) corer is recommended by Standard Methods for obtaining estimates of the standing stock of benthic macroinvertebrates inhabiting soft sediments.

Wildco K-B Corer (<http://shop.sciencefirst.com/wildco/k-b-corers/7815-k-b-corer.html>)

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**ATTACHMENT 3**  
**DREDGES**

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## PONAR



WILDCO Ponar Dredge ([http://www.benmeadows.com/wildco-ponar-grabs\\_36816477/](http://www.benmeadows.com/wildco-ponar-grabs_36816477/))

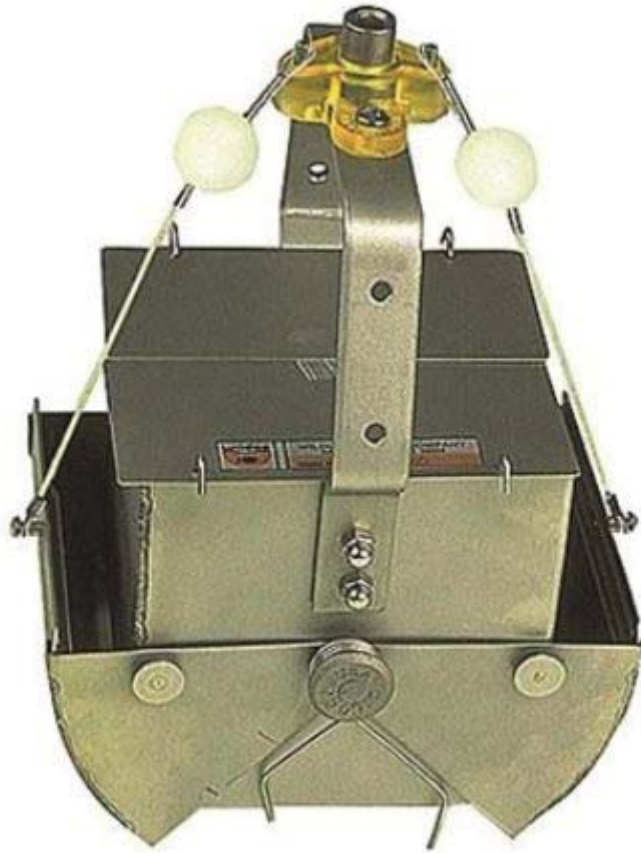
## PETERSON



WILDCO Peterson Dredge (<https://www.coleparmer.com/p/mn/7270>)



## EKMAN



EKMAN Dredge ([http://www.benmeadows.com/ekman-bottom-grab-sampler\\_36816471/?searchterm=ekman%2bdredge](http://www.benmeadows.com/ekman-bottom-grab-sampler_36816471/?searchterm=ekman%2bdredge))

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**ATTACHMENT 4**  
**FIELD SAMPLING REPORT**

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# FIELD SAMPLING REPORT

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**SOP 411.02, SIB Project Area, PHSS**  
**(Source: Sampling Equipment Cleaning and Decontamination)**

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	<b>STANDARD OPERATING PROCEDURE</b>	
	Approved by: <b>Dick, Jeff</b>	Digitally signed by Dick, Jeff Date: 2020.06.18 16:05:40 -04'00' Corporate Quality Manager
<b>Sampling Equipment Cleaning and Decontamination</b>	<b>SOP No.: 411.02 (formerly 2.01)</b>	
	<b>SOP Category: Environmental Services</b>	
	<b>Revision No.: 5</b>	
	<b>Revision Date: June 18, 2020</b>	
	<b>Review Date: June 2022</b>	

## 1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe field methods to be used for cleaning and decontaminating sampling equipment.

This procedure is specifically applicable to sampling equipment that has been used to collect environmental samples or could have been exposed to contamination that could affect worker safety and/or the integrity of the analytical results of the media sampled.

Other decontamination procedures may apply to a specific project; refer to the project-specific planning documents for project-specific decontamination methods and schedules.

Any deviations from specified requirements must be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements are documented sufficiently to re-create the modified process.

## 2.0 SUMMARY OF THE METHOD

This SOP describes the procedures to be followed to achieve effective decontamination as follows: (1) remove contaminants from contaminated surfaces, (2) minimize the spread of contamination to uncontaminated surfaces, (3) avoid any cross-contamination of samples, and (4) minimize personnel exposures. The intent is to accomplish the required level of decontamination while minimizing the generation of additional solid and liquid waste.

## 3.0 DEFINITIONS

*ASTM Type II Water:* This is the type of deionized reagent grade water, as defined by ASTM International, used in the final rinse of surfaces of contaminated equipment.

*Equipment:* Equipment comprises those items (variously referred to as “field equipment” or “sampling equipment”) that are necessary to conduct sampling activities but that do not directly contact the samples.

*Laboratory Detergent:* This is a standard brand of phosphate-free laboratory detergent such as Liquinox® or Luminox®. Liquinox® is a traditional anionic laboratory detergent used for general cleaning and when there is concern that harsher cleaners could affect the stability of the sampling equipment. Luminox® is a specialized detergent that can remove oils and organic contamination. It may be used in lieu of a solvent rinse step in cleaning equipment for trace contaminant sampling.

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Where not specified in these procedures, either detergent is acceptable. The project-specific plans should indicate if Luminox® use is acceptable.

*Organic-free Water:* This is tap water that has been treated with activated carbon and deionizing units. At a minimum, the finished water must meet the analytical criteria of deionized water, and it should contain no detectable pesticides, herbicides, or extractable organic compounds and no volatile organic compounds above minimum detectable levels for a given set of analyses. Organic-free water obtained by other methods is acceptable as long as it meets the above analytical criteria.

*Potable/Tap Water:* Potable/tap water is provided by local city sources and is safe for consumption. Chemical analysis of the water source is not required before it is used. Deionized water or organic-free water may be substituted for tap water.

*Sampling Devices:* This is equipment used to acquire samples.

## 4.0 GENERAL REQUIREMENTS

All work is performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements. Any deviations from specified requirements must be justified to and authorized by the project manager and/or the relevant program manager. Deviations from requirements are documented sufficiently to re-create the modified process.

## 5.0 EQUIPMENT AND SUPPLIES

The following equipment is specific to decontamination requirements and does not include required safety equipment and field documentation described in the site-specific plans. Project-specific plans should be consulted for any additional equipment or deviations from the list below:

- Laboratory detergent,
- Brushes (not wire wound),
- Paper towels/rags,
- Squeeze bottles (one for each decontamination fluid),
- 5-gallon buckets or decontamination pad/kiddie pool to contain decontamination fluids,
- Potable water,
- Deionized water,
- Drums or containers for decontamination fluids/solids,
- Drum/container waste labels,
- Sampling containers for decontamination fluid/solid sampling,
- Aluminum foil,
- Steam cleaner, and
- Generator and fuel.

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## 6.0 PROCEDURAL STEPS

Decontamination of sampling devices is performed in a designated decontamination area, removed from any sampling or dedicated office location. This designated area must be in a location free of direct exposure to airborne and radiological surface contaminants and upwind of any field activities that could jeopardize the decontamination procedures or cross contaminate the cleaned equipment.

### 6.1 GENERAL

The following general rules are followed for decontamination operations:

- Contaminated or dirty sampling devices/equipment should not be stored with or above clean (decontaminated) sampling devices/equipment.
- Clean, decontaminated sampling devices should be segregated from all other equipment and supplies.
- Paint or any other coatings must be removed from any part of a sampling device that may either contact a sample or may otherwise affect sample integrity. After such coatings are removed, the sampling device must be decontaminated using the appropriate method.
- For any of the specific decontamination methods that may be used, the substitution of higher-grade water is permitted (for example, using deionized water in place of tap water). However, deionized water is less effective than tap water in rinsing away detergent during the initial rinse.
- Decontaminated sampling devices and all filled and empty sample containers are stored in locations protected from exposure to any contaminant.
- The method for decontaminating sampling devices and the exterior of sample containers that have been exposed to radioactive material is based on the material contaminated, the sample medium, the radiation levels, and the specific radionuclides to be removed.
- The release of decontaminated sampling devices and sample containers for unrestricted use is based on site-specific criteria. These site-specific criteria should be detailed in the project-specific plans.
- Rags/paper towels used during decontamination activities may become a hazardous waste and require segregation. Refer to the project-specific plans for hazardous waste disposal requirements.
- Sampling devices must be decontaminated before being used in the field to prevent potential cross-contamination of a sample.
- Sampling devices must be decontaminated between samples to prevent cross-contamination.

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- Sampling devices must be decontaminated at the close of the sampling event before being taken off site.
- An acceptable alternative to cleaning and decontaminating sampling devices is using items cleaned or sterilized by the manufacturer that are discarded after one use. Care must be exercised to ensure that such previously cleaned or sterilized items do not retain residues of chemical or radioactive sterilizing agents that might interfere with analytical techniques.
- Whenever visible dirt, droplets of liquid, stains, or other extraneous materials are detected on the exterior of a sample container, the exterior surfaces must be decontaminated. This step should be performed before the container is placed in a sample cooler or shipping container.
- For sample containers used in controlled access areas, more rigorous cleaning and/or radiation monitoring may be required before removal from the site. Refer to the project-specific planning documents for details.
- Decontamination fluids/solids as well as other used cleaning supplies, such as paper towels and rags, should be treated as investigation-derived waste and managed in accordance with the project-specific planning documents.

## 6.2 DECONTAMINATION METHODS

The following decontamination methods are examples of some of those most commonly used in field investigations. Note that the decontamination methods described in this section are for guidance only; the project-specific planning documents and the SOPs referenced in them provide the actual procedures that must be followed. The field operations manager may need to adjust decontamination practices to fit the sampling situation and applicable requirements. All variances from the project-specific planning documents must be approved by the project manager in advance and documented. Procedures for packaging and disposing of all waste generated during decontamination are described in the project-specific planning documents.

### 6.2.1 Water Level Indicators

The following steps are taken to decontaminate water level indicators. Unless conditions warrant, it is only necessary to decontaminate the wetted portion of the measuring tape. It may be more practical to decontaminate the tape as it is being rewound, but with the reel several feet away from the wellhead (see project-specific planning documents):

1. Wash with detergent and tap water.
2. Rinse with tap water.
3. Rinse with deionized water.

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### 6.2.2 Submersible Groundwater Pumps

The following procedures are taken to decontaminate submersible pumps used to collect groundwater samples. This is the general procedure for non-dedicated pumps, unless the dedicated pump is being removed from the well.

1. Disconnect and discard the previously used tubing from the pump. Wash the pump exterior with detergent and water.
2. Prepare and fill three containers with decontamination solutions consisting of Container 1, tap water and detergent solution; Container 2, a tap water rinsing solution; and Container 3, a deionized water final rinsing solution. The containers should be large enough to hold the pump and 1 to 2 liters of solution. An array of 2-foot-long 2-inch PVC pipes with bottom caps is a common arrangement. Buckets can also be used as long as the water covers the intake screen of the pump. The containers should be labeled to ensure that decontamination is completed in the correct steps. The solutions should be changed at least daily.
3. Place the pump in Container 1. Turn the pump on and circulate the detergent and water solution through the pump and then turn the pump off.
4. Place the pump in Container 2. Turn the pump on and circulate the tap water through the pump and then turn the pump off.
5. Place the pump in container 3. Turn the pump on and circulate the deionized water through the pump and then turn the pump off.
6. Disconnect the power and remove the pump from Container 3.
7. Decontaminate the power lead by washing it with detergent and water, followed by tap water and a deionized water rinse. This step may be performed before washing the pump, if desired.
8. Wind the power lead back on a reel, and place the pump and reel in a clean plastic bag.

### 6.2.3 Bladder Pumps

The following procedures are used to decontaminate bladder pumps that use disposable bladders. If the bladder pump being used does not have a disposable bladder, the decontamination procedures outlined in Section 6.2.2 should be used.

1. Disconnect and discard previously used tubing from the pump.
2. Completely disassemble the pump, being careful not to lose the check balls, O-rings, ferrules, or other small parts.
3. Remove and discard the pump bladder.

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4. Clean all parts with tap water and detergent, using a brush if necessary to remove particulate matter and surface films.
5. Rinse thoroughly with tap water.
6. Rinse thoroughly with deionized water.
7. Install a new pump bladder.
8. Reassemble the pump and wrap it in aluminum foil or store it in a decontaminated pump storage tube.

#### **6.2.4 Small Tools/Samplers**

The following procedures are used to decontaminate small tools/samplers (e.g., stainless steel bowls, sample trowels, and hand augers).

1. Wash the tools/samplers with detergent and tap water, using a brush to remove particulate matter and surface film.
2. Rinse thoroughly with tap water.
3. Rinse thoroughly with deionized water.
4. Wrap the tools/samplers in aluminum foil or place them in a clean plastic bag.

#### **6.2.5 Drilling and Direct-Push Technology Sampling Equipment**

These procedures are used for drilling and direct-push technology (DPT) sampling activities involving the construction of monitoring wells to be used for collecting groundwater samples or for collecting soil and groundwater samples.

##### **6.2.5.1 Drill and DPT Rig**

Any portion of the drill or DPT rig or backhoe over the borehole or sample location that has come into contact with soil or groundwater (mast, backhoe bucket, drilling platform, hoist, cathead) should be steam cleaned (detergent and high-pressure hot water) between boreholes or sample locations. A decontamination pad should be constructed as specified in the project-specific plans to contain soil and decontamination fluids.

##### **6.2.5.2 Downhole Drilling and DPT Equipment**

The following is the standard procedure for field cleaning augers, drill stems, rods, tools, and associated equipment.

1. Wash the equipment with tap water and detergent, using a brush if necessary to remove particulate matter and surface film. Steam cleaning may be necessary to remove matter that

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is difficult to remove with the brush. Drilling equipment that is steam cleaned should be place on racks above the floor of the decontamination pad. Hollow-stem augers, drill rods, drive casing, and other equipment that is hollow or has holes that transmit water or drilling fluids should be cleaned on the inside with vigorous brushing or steam cleaning.

2. Rinse the equipment with tap water.
3. Remove the equipment from the decontamination pad and cover it with clean plastic or reinstall the equipment on the drill rig.

### 6.3 QUALITY CONTROL

The effectiveness of the decontamination procedures is monitored by submitting samples of rinse water to the laboratory for low-level analyses of the parameters of interest, also referred to as equipment blanks. An attempt should be made to select different sampling devices each time devices are decontaminated to ensure that a representative sampling of all devices is obtained over the length of the project. Equipment blanks should be collected as specified in the project-specific planning documents.

## 7.0 RECORDS

Documentation generated as a result of this procedure is collected and recorded in a field logbook in accordance with procedures listed in SOP 300.04: *Field Logbook Use and Maintenance*.

## 8.0 REVISION HISTORY


Revision 0		Initial Release
Revision 1	December 2010	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2		Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 3	July 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 4	February 2018	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 5	June 18, 2020	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting, which included changing the SOP number from 2.01 to 411.02.

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**SOP 411.03, SIB Project Area, PHSS**  
**(Source: Subsurface Utility Avoidance)**

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	<b>STANDARD OPERATING PROCEDURE</b>	
	Approved by:	Corporate Quality Manager
<b>Subsurface Utility Avoidance</b>	<b>SOP No.: 411.03 (formerly 401.01)</b>	
	<b>SOP Category: Environmental Services</b>	
	<b>Revision No.: 3</b>	
	<b>Revision Date: September 29, 2020</b>	
	<b>Review Date: September 2022</b>	

## 1.0 SCOPE AND APPLICABILITY

This procedure applies to work that involves penetrating the soil surface with powered equipment during drilling or excavation activities. It is permissible to use a client's or facility owner/operator's utility avoidance procedure in lieu of this procedure if it provides equivalent protection.

For overhead utility lines avoidance, see the following procedures:

- HGL H&S Procedure 21: *Excavation and Trenching*,
- HGL H&S Procedure 27: *Drilling Safety*,
- HGL H&S Procedure 32: *Aerial Lift and Elevated Work Platform*, and
- HGL H&S Procedure 40: *Forklifts and Earthmoving Equipment*.

## 1.1 SUMMARY OF METHOD

This procedure establishes the minimum requirements for avoiding damage to subsurface utilities from unintentional contact with powered equipment.

## 1.2 HEALTH AND SAFETY WARNINGS

This procedure is not intended to address the hazards associated with subsurface investigation activities. Consult HGL Health and Safety (H&S) Procedure 21: *Excavation and Trenching* and Procedure 27: *Drilling Safety* for safety guidance and requirements. Do not perform intrusive work in areas that may contain unexploded ordnance (UXO) without a UXO escort and clearance by qualified UXO personnel.

Follow the procedures below if a utility is damaged during work (refer to the project Health and Safety Plan or Accident Prevention Plan for project contact information):

- If a gas line has been breached, shut down all nearby equipment that might provide an ignition source.
- Evacuate the immediate area of the breach unless the breached item clearly poses no hazard to personnel, as determined by the Site Safety and Health Officer (SSHO).
- Notify the owner/manager of the utility and emergency services (as appropriate) immediately. Note that in many cases contacting the public utility locating service (using One Call, calling 811, or going online to <https://call811.com>) will notify the member utility. In some states it is required by law to notify the One Call service.

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- If a buried electrical line is cut or damaged, call the power company emergency number for instructions.
- Notify the HGL Project Manager and H&S Director.
- Do not proceed with activities until the situation has been assessed by qualified H&S or utility owner personnel and written permission to resume work has been granted by the Project Manager and H&S Director.

### 1.3 PERSONNEL RESPONSIBILITIES

The Project Manager is responsible for the following:

- Obtaining any facility-specific requirements/procedures for intrusive work, such as a dig permit;
- Obtaining specifications and “as-built” drawings for any buried lines, utilities, tanks, or other structures at the site and reviewing the proposed locations for drilling or excavation relative to those structures;
- Verifying that if client or facility utility avoidance procedures are to be used, they provide protection that is equivalent to that provided by this HGL SOP;
- Arranging for additional utility location beyond One Call service, such as private utility locating subcontractors, if
  - No accurate utility maps or “as-built” drawings are available,
  - Work is being performed close to high-value or high-hazard buried utilities, or
  - Work is being performed in residential areas, inside buildings, outside of public rights-of-way, or in other locations where unmapped utilities may be present.
- Arranging for UXO escort and UXO clearance if unexploded ordnance may be present;
- Ensuring that utility owner/manager emergency phone numbers are in emergency contact lists; and
- Ensuring that arrangements and procedures for subsurface utility avoidance are addressed during the pre-mobilization readiness review. These include establishing procedures for intrusive activities within 5 feet of a utility; arranging for HGL not to be responsible for damages to subsurface utilities in accordance with the One Call service or facility liability provisions; and obtaining a written waiver from the client or site owner, if needed.

The Field Manager is responsible for the following:

- Contacting the state utility One Call service and/or facility utility program to locate and mark subsurface utilities and hazards at the worksite and to update them during the duration of the work;

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- Completing the utility avoidance checklist attached to this SOP before the start of intrusive work;
- Ensuring that fieldwork involving powered drilling or excavation follows this procedure and other applicable requirements including HGL H&S procedures;
- Ensuring that site personnel are trained on the requirements of this SOP;
- Discussing utility-related emergency procedures in the pre-mobilization readiness review and daily safety briefings;
- Ensuring that all drilling or excavation locations are marked using high-visibility paint or some other recognizable and durable marking;
- Reviewing utility maps against field markings and resolving any inconsistencies or questions with the One Call service or facility utility program;
- Verifying at the start of each workday that drilling/excavation and utility markings are intact and clear, and contacting the One Call service or facility utility program to re-mark utilities if necessary;
- Understanding the utility incident reporting requirements for the state and facility where the work is done; and
- Reporting immediately any unintentional contact or damage to subsurface assets or hazards.

## **1.4 DATA AND RECORDS MANAGEMENT**

Steps taken to avoid damaging utilities must be documented in the appropriate records such as the utility avoidance checklist, pre-drilling checklist, inspection checklist from H&S Procedure 21, field logbooks, and photographs, including photographs of the utility marks relative to the boring/excavation prior to the start of intrusive activities. Copies of utility maps, completed dig permits, and other relevant documentation must be kept at the project site and in the project files.

## **2.0 PROCEDURE**

The Field Manager is responsible for executing this procedure on the project site and completing the Utility Avoidance Checklist in Attachment 1 before the start of intrusive work.

Before commencing intrusive work using powered equipment, contact the public utility locating service (using One Call, calling 811, or going online to <https://call811.com>), the facility's utility program, or a private utility contractor. Utilities not in the public right-of-way are typically not marked by the One Call service.

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Complete a walk-over survey of excavation or drilling locations prior to intrusive activities and then visually confirm that known utilities have been marked as appropriate and that markings are consistent with visible cues of possible subsurface utilities including the following:

- Utility posts/line markers,
- Water shutoff valves,
- Sewer cleanouts/manhole covers,
- Discharge pipes,
- Stormwater inlets,
- Irrigation wells and pivots,
- Fire hydrants (hydrants are typically offset from the water main by several feet),
- Junction boxes,
- Electrical poles with conduit into the subsurface,
- Light poles,
- Storage tank vents,
- Transformers, and
- Cuts/patches in pavement.

Determine if proposed drilling or excavation locations are immediately between storage tanks and product dispenser systems, between storage tanks and control units or buildings, between underground storage tanks and tank air vents, between manholes and sewer connections, or between any features that are likely to be connected by a subsurface utility, and if they are, relocate the drilling/excavation locations if possible. Identify facility assets (for example, equipment, control centers, fire suppression systems, vital communication systems, hospitals, police stations) that may be impacted or harmed if a utility is breached. Know the location of any shutoff valves in the area (for example, irrigation lines). Take photographs of all drilling and excavation locations prior to, during, and after work is complete.

Contact the One Call service or facility utility program if a utility is encountered that has not been marked or communicated to complete the locate and marking for that utility. If a utility is encountered and has not been marked or communicated by the One Call service or facility utility program, notify the Project Manager and H&S Director, who will determine the next step, such as arranging an independent utility survey and notifying the One Call service or facility utility program of the failure.

If a planned intrusive location is within 5 feet of a utility, reposition the work if feasible and request a new utility clearance by the One Call service. Consult the Project Manager before deciding to relocate a planned drilling or excavation location; obtain client approval if necessary. Keep in mind that many utility markings are approximations and that the utilities may be several feet from the markings.

<b>Subsurface Utility Avoidance</b>	<b>SOP No.: 411.03 (formerly 401.01)</b>
	<b>SOP Category: Environmental Services</b>
	<b>Revision No.: 3</b>
	<b>Revision Date: September 29, 2020</b>
	<b>Review Date: September 2022</b>

For drilling operations, if it is not feasible to relocate the drilling location, excavate at least the first 5 feet (deeper if it is likely that there are deeper utilities) of boreholes with a low-impact technique such as hand augering, hydrovacing, or air knifing. Pre-excavation of boreholes using low-impact techniques must also be performed under the following conditions:

- The location of utilities is uncertain.
- The work is being done in a residential or high population commercial area.

It is permissible to omit low-impact pre-excavation of boreholes under the following conditions:

- It has been verified that no hazardous (for example, gas, liquid fuel, or electric) or mission-critical communication (for example, fiber optic) subsurface utilities exist within 25 feet of the planned drilling location and that HGL will not be responsible for damages to subsurface utilities in accordance with the One Call service or facility liability provisions; or
- A written waiver has been obtained from the client or site owner.

Situations that do not fit the above criteria should be resolved at the pre-mobilization readiness review. Decisions to forego low-impact pre-excavation of drilling boreholes are subject to Program Manager approval through the issuance of a Subsurface Utility Avoidance memorandum or Field Work Variance. The memorandum must detail the justification to forgo the procedures outlined in this SOP, H&S Procedure 21: *Excavation and Trenching* and H&S Procedure 27: *Drilling Safety*. The revised procedure must be discussed during the readiness review meeting with all task participants, and the signed memorandum must be included with the readiness review form and/or pre-drilling checklist.

Criteria for determining the need to pre-excavate boreholes are summarized below:

<b>Criterion</b>	<b>Utility Location</b>	<b>Other Condition</b>	<b>Decision</b>
a	Within 5 feet		Pre-excavate
b	Between 5 and 25 feet	Uncertain if utilities are present	Pre-excavate
c	More than 25 feet	No hazardous or high-value utilities are present	May skip pre-excavation
d	Uncertain	Residential or high-population commercial	Pre-excavate
e	Uncertain	No hazardous or high-value utilities are present; HGL liability waived	May skip pre-excavation
f	Uncertain	Not d or e	Site-specific; resolve at pre-mobilization readiness review and document in review minutes

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For excavation operations, if utilities are located within the planned excavation or within 5 feet of the limits of the excavation, the precise location of those utilities must be determined by excavating with low-impact tools such as hand auger, shovel, hydrovac or air knife. This may be necessary at several locations within the excavation area to confirm that the apparent route and depth of the utility do not change. **If a utility extends throughout the area to be excavated, the utility must be exposed to confirm its location and depth at least once every 10 feet. The utility must be exposed continuously, using low impact techniques, when performing powered excavation within 5 feet of the utility.**

HGL must inspect excavations managed by subcontractors at sufficient frequency and at least daily to confirm that the subcontractor is complying with these requirements and must require the subcontractor to make corrections if they are not in compliance.

If subsurface obstructions prevent reaching a depth of 5 feet using low-impact techniques, verify that the obstruction itself is not a utility (for example, a concrete sewer pipe versus concrete rubble). Conversely, if there is a credible probability that utilities are present at depths greater than 5 feet, the low-impact excavation may be continued to greater depths. **It is not permissible to omit low-impact excavation due to a lack of suitable equipment.**

Inspect the low-impact excavation and excavated material for indications of utilities, such as the edge of a pipe visible in the sidewall of the excavation or the presence of pea gravel that may be pipe bedding. If a subsurface utility is unintentionally encountered at any time during a low-impact or powered boring or excavation, cease all work in the immediate area and contact the SSHO and Field Manager.

Any material generated during pre-excavation activities is managed in accordance with the project-specific planning documents.

Maintain and protect markings for utility locations during the work. If utility markings are weathered away or removed, or if the location or boundaries of the activity change, repeat the locating processes and replace the markings. Many utility incidents occur when the boundaries of excavations are changed or the marked utility locations wear off.

### 3.0 REFERENCES

HGL, H&S Procedure 21: *Excavation and Trenching*.

HGL, H&S Procedure 21.1: *Excavation and Trenching*, Appendix A, Inspection Checklist.

HGL, H&S Procedure 27: *Drilling Safety*.

HGL, H&S Procedure 32: *Aerial Lift and Elevated Work Platform*.

HGL, H&S Procedure 40: *Forklifts and Earthmoving Equipment*.



<b>Subsurface Utility Avoidance</b>	<b>SOP No.: 411.03 (formerly 401.01)</b>
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	<b>Review Date: September 2022</b>

### 3.0 REVISION HISTORY

Revision 0	July 2016	Initial Release
Revision 1	May 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	June 1, 2018	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 3	September 29, 2020	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting, which included changing the SOP number from 401.01 to 411.03.

### ATTACHMENTS

Attachment 1 – Utility Avoidance Checklist

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**ATTACHMENT 1**  
**UTILITY AVOIDANCE CHECKLIST**

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## UTILITY AVOIDANCE CHECKLIST

Date: \_\_\_\_\_ Project/Site: \_\_\_\_\_

Field Manager: \_\_\_\_\_

Work to be Performed: \_\_\_\_\_

Consideration	Y	N	Explanation	Initial
1. Has a dig permit been obtained and approved?				
2. Has state One Call service been contacted?				
3. Has facility utility program been contacted?				
4. Has a private utility locating survey been conducted?				
5. Have as-built drawings been reviewed for utilities or subsurface hazards (e.g., USTs)?				
6. Has a visual inspection of the work area(s) been completed, including taking photographs?				
7. Have all known utilities and subsurface hazards been clearly marked?				
8. Has a visual inspection indicated the possible presence of other utilities or subsurface hazards?				
9. Are intrusive activities being conducted within 5 feet of a utility?				
10. If Item 9 is YES, can activity be relocated?				
11. Are any final drilling locations within 5 feet of a utility; are utility locations uncertain or working in residential or high population area? If YES, excavate first 5 feet using low-impact techniques				
12. Are any utilities within 5 feet of the excavation limits? If YES, determine precise location with low-impact techniques.				
13. Can drilling proceed WITHOUT excavating the upper 5 feet with low-impact techniques? Explain why.				
14. If working near overhead power lines, is a minimum clearance of 20 feet being maintained?				
15. Has written approval been granted by the Program Manager to deviate from SOP 411.03? Attach to checklist.				
Other considerations:				

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**SOP A-1, SIB Project Area, PHSS**  
**(Source: Hydrocarbon Field Screening)**

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# **Standard Operating Procedure**

## **Hydrocarbon Field Screening by Sheen Test**

### **1.0 Purpose and Applicability**

The Standard Operating Procedure (SOP) for sheen test describes a procedure to visually estimate areas of possible hydrocarbon impacts in soil or sediment. In addition, screening results can be used to aid in the selection of soil/sediment samples for chemical analysis. The field screening method includes a visual examination and water jar screening test.

Visual screening consists of inspecting the soil/sediment for stains, nonaqueous-phase liquids (NAPL), and/or sheens indicative of residual hydrocarbons. Visual screening is most effective at detecting heavy hydrocarbons, such as creosote, free-phase NAPL or high hydrocarbon concentrations. Water sheen screening from a representative soil/sediment sample is a more sensitive method at detecting the presence of hydrocarbons.

### **2.0 Responsibilities**

The project manager is responsible for ensuring that a properly designed sampling program is prepared prior to any sample collection. The field sampling coordinator will have the responsibility to oversee and ensure that all sampling is performed in accordance with the project-specific sampling program and this SOP. In addition, the field sampling coordinator must ensure that all field workers are fully apprised of this SOP.

### **3.0 Health and Safety**

This section presents the potential hazards associated with this technique. The site-specific Health & Safety Plan (HASP) will take precedence over this document. Note that sample collection usually requires Level D personal protection unless there is a potential for airborne or dermal exposures to site contaminants.

Health and safety hazards include but are not limited to the following:

- Dermal exposure to potentially contaminated media: proper personal protective equipment (PPE) is used to mitigate dermal contact including the impact of splashes of water or media to skin and/or eyes;
- Inhalation exposure when handling impacted media: respiratory protection should follow the procedures outlined in the project Site-Specific HASP; and
- Broken glass, in the event that a glass jar is used: use care when handling glassware.

### **4.0 Supporting Materials**

The following materials must be on hand in sufficient quantity to ensure that proper screening procedures may be followed:

- Approximately one cubic-inch of media to be screened;
- 4 of 8 oz. wide-mouth, clear glass jar;
- Stirring devise (i.e. spoon);
- Squirt bottle; and
- Supply of distilled water.

## 5.0 Methods and Procedures

The strategy used to collect soil/sediment samples in the field for sheen testing will depend on the nature/grain size of the material and the type of hydrocarbon. Discrete samples may be collected from specific depths where NAPL is likely to occur. When lithology is coarse-grained material over fine-grained material, then a sample should be collected just above this interface where NAPL may be pooling above the “aquitarde”. Similarly, where fine-grained material overlies a coarse-grained layer with suspected impacts, the sample should be collected just below the contact. When lithology is fine-grained, then a sample should be collected near the contact with the coarse-grained layer. Alternatively, when lithology is finely bedded (< 1-inch thick), then homogenized samples may be collected over a larger depth interval to gain an “average” observation.

If the sample is being collected from inside a sediment core tube, the tube should be cut open longitudinally along the length of the core tube to prevent additional smearing. Make sure the interior of the sediment is exposed as a “fresh surface”. Be sure to discard any material along the inside side-walls of the core tube; this is called the “smear zone”. The smear zone may mask the true stratigraphy of a subsurface core sample. Then, use a spoon to scrap material across the “fresh” surface of the depth interval of interest, and place into sample jars for further observation. Once the sample volume is collected (approximately 1 oz or more depending upon grain size) the sample is examined and tested as described below.

### Visual Examination

In the field, observe sediment core tubes or soil samples for evidence of NAPL. Look at the material and note color and type/nature of occurrence. Observe the exterior and interior sidewalls of the sampling container for signs of staining. If wet, observe the nature of liquid. Among gravels, observe the surface of the gravel for signs of sheen and/or NAPL.

### Water Sheen Test

Water sheen screening involves placing soil/sediment in a clear glass jar or a black plastic pan partially filled with water, and observing the water surface for signs of a sheen. The volume of soil/sediment required for observation is approximately one cubic inch, or 10 mls, or about one tablespoon of media. For practical application in the field or lab, place about one cubic inch of soil/sediment (roughly 1 oz) in a 4 to 8 oz jar filled ¼-full with water. For larger volumes, use about 2 oz of material in an 8 oz wide-mouth glass jar filled ¼-full with water. Even larger volumes are needed for gravel. A plastic baggy may be substitute for a glass jar if field conditions require. Crush the material in the jar using a stirring devise (i.e., spoon), and shake the sealed jar vigorously for 30 seconds and allow the material to settle. Observe the water surface and sidewalls of the jar for signs of sheen, LNAPL, and DNAPL. Quantify the amount of sheen and blebs in the water surface using the following sheen classification:

No Sheen	No visible sheen on water surface
Slight Sheen	Light, colorless, dull sheen; spread is irregular, not rapid; sheen dissipates rapidly
Moderate Sheen	Light to heavy sheen, may have some color/iridescence; spread is irregular to flowing, may be rapid; few remaining areas without sheen on water surface
Heavy Sheen	Heavy sheen with color/iridescence; spread is rapid; entire water surface may be covered with sheen; visible droplets of immiscible liquids (i.e. NAPL)

Quantify the spatial coverage of sheen and size/diameter NAPL blebs if observed. The color is often described as rainbow or metallic for sheens and dark brown to black for blebs, droplets, and staining. Observe the sidewalls of the jar and estimate the thickness of LNAPL on the water surface and the thickness of DNAPL accumulated at the bottom of the jar. Record visual signs of staining on jar sidewalls and stirring device.

Field screening results will be recorded on the field logs forms or in a field notebook. Field screening results are site-specific and location-specific. Factors that may affect the performance of this method include: operator experience (experimentation may be required before routine screening is started) ambient air temperature, soil type, soil moisture, organic content, and type of hydrocarbon. Headspace screening may be collected to help correlate results and observations.

## 6.0 Quality Assurance/Quality Control

Not applicable.

## 7.0 Documentation

Documentation may consist of all or part of the following:

- Field sampling forms;
- Field log book; and
- Chain-of-custody forms.

Field records should contain sufficient detail to provide a clear understanding of how and where samples were collected. All documentation shall be placed in the project files and retained following completion of the project.

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## **Field Description Key for Potential NAPL in Sediment**

The intent of this field description key is to provide field personnel with guidelines for logging and observing sediment conditions associated with potential presence of Non-Aqueous Phase Liquid (NAPL) in a consistent and factual manner.

### **VISUAL DESCRIPTORS**

The range of conditions that could exist in sediments include:

- **NAPL** (Non-Aqueous Phase Liquid) – a separate phase liquid that may be lighter than water (LNAPL) or denser than water (DNAPL). NAPL can have varying consistency (viscosity) and can range from non-viscous to highly viscous (taffy-like). NAPL observations should be accompanied by applicable olfactory with smell (see descriptors below) and other visual observations (e.g., color and viscosity). The visual appearance of NAPL should be noted using descriptors below as appropriate. If NAPL is identified, then a sheen or shake test should be completed as described in this SOP in the Hydrocarbon Field Screening by Sheen Test portion.
  - **Free Product** – the entirety of the pore space for a sample interval is saturated with NAPL. Care should be taken to ensure that the saturation described is not related to water in the sample. Depending on the viscosity, NAPL saturated materials may freely drain from a soil sample and should be documented accordingly.
  - **Present**– In some cases, NAPL may be present in the pore spaces, or some of the pore spaces, but not coating the soil grains. The NAPL occurrence may be greater than blebs but not freely draining (saturated) and not hydraulically continuous. In these cases, the appearance/abundance of the NAPL should be noted.
  - **Blebs or Globules**– discrete, multi-shaped NAPL in or on the soil matrix. Include additional descriptors to the extent practicable such as the approximate size (typically ranging in size from 0.01 to 0.05 inches in diameter) and quantity (number of blebs or qualitative estimate) to the extent practical.
  - **Coated** – soil grains are coated with NAPL – there is not sufficient NAPL present to saturate the pore spaces. Use modifiers such as light, moderate or heavy to indicate the degree of coating.
  - **Semi-solid NAPL**– NAPL that is present as a super viscous liquid and appears in a solid or semi-solid phase. The magnitude of the observed solid NAPL should be described (discrete granules, tarry balls, taffy-like, or a solid layer).
- **Sheen** – iridescent sheen. The sheen characteristics need to be described in the field log, including the color, and iridescent sheens need to be distinguished from bacterial sheens which tend to break up at angles on the water surface; whereas a non-bacterial sheen will be continuous and will not break up. Sheens can be described as:
  - Discontinuous sheen (i.e., spotty, streaks, florets) within a section of core and does not fill sediment pore spaces.

- Continuous sheen (i.e., covering an area greater than 1 square inch) within a section of core but does not fill pore spaces. Describe percent cover.
- **Stained** – visible, unnatural discoloration of the soil, with no visible NAPL.

### **Other Visual Impacts and Descriptors**

In many cases, observed NAPL may be associated with a particular stratigraphic layer (e.g, sand lamination, woody debris layer, gravel lense), gas bubble, or void; NAPL distribution in relation to stratigraphy must be described. What does the material look like immediately above and below the area with suspected NAPL (e.g, clay). Impacts should be described using other visual descriptors as well, as applicable. Descriptors may include, but not be limited to, color, consistency, thickness, viscosity, water content, associated stratigraphy, presence shell or wood fragments or other debris, does NAPL flow out of the core tube, does it appear more or less viscous than water, results of jar sheen test, etc. Also note the staining of sampling equipment, and interior and exterior side-walls of the sampling tube, especially if entrainment of NAPL up the side-walls is suspected as an artifact of sample collection.

### **OLFACTORY DESCRIPTORS**

Field personnel will not conduct olfactory testing as part of sample processing, because vapor inhalation is a potential health and safety risk. However, if incidental odors are noted by field personnel during regular sample processing activities, field personnel will record this observation in the field forms. General descriptors that could be used are the following:

- Note odors similar to mothballs, driveway sealer, highway paving oil, sewage or other odors that are acrid, burnt, or sulfur-like, etc.
- Other odors that are not believed to be natural should also be identified with descriptors such as organic, ammonia, sweet, chemical etc., as applicable.
- Use modifiers such as strong, moderate or slight to indicate intensity of the observed odor.
- In instances where multiple odors are present, a combination of descriptors should be used to clearly identify where these co-mingled impacts are present.

However, olfactory descriptions are more subjective than visual inspections. Visual inspection may be aided by a PID, ultraviolet (UV) fluorescence examination, shake test, or similar device, to monitor and record organic odors and suspected NAPL in the field. One may also consider collecting a sample of the suspected NAPL to assess physical characteristics and potential mobility.

*Last revised by AGF and Geosyntec on 1/18/18*

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**SOP A-2, SIB Project Area, PHSS**  
**(Source: PID Screening and Calibration Procedures)**

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## **PID Field Screening (Integral 2004)**

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Except for sample volumes collected for volatile analytes, sediment from each subsample will be individually mixed in the decontaminated, stainless-steel bowl to a uniform color and texture using a decontaminated, stainless-steel spoon. The sediment will be stirred periodically while individual samples are taken to ensure that the mixture remains homogeneous. Care will be taken to not include sediment that is in direct contact with the aluminum tube. In addition, the cutting of the aluminum tube can introduce metal shavings to the core sediment. Care will also be taken to avoid mixing these shavings into the homogenate. Pre-labeled jars for chemical testing will be filled with the homogenized sediment.

The types and number of field QC samples for subsurface sediment samples will follow the same guidelines prescribed for surface sediment samples. If additional volumes of sediment are required to perform all analyses in addition to QC analyses, an additional core may need to be collected from the same location and subsampled and homogenized accordingly.

Sample handling and storage procedures will follow those described for surface sediment samples in Section 4.6.1 with the following exception. When required, sediment subsamples for volatile organics will be collected from within appropriate intervals following the opening of the core and designation of the lithologic units. This process will minimize the release of volatile organics caused by mixing. Rinsate blanks will be performed at the same frequency (5%) as performed for the surface sediment sampling program.

#### **4.6.4 Subsurface Sediment Sample Field Screening**

In addition to visual observation, headspace screening using a photoionization detector (PID) and/or flame ionization detector (FID) may be used on all sample intervals to aid in the selection of samples to be analyzed.

##### **Headspace Screening**

Headspace screening involves the semi-quantitative measurement of total volatile compounds in the air above the sample material. Headspace concentrations will be measured using the following procedure.

1. A small representative sample will be collected from each sample interval to be screened using a decontaminated sampling spoon. The material will be placed in a resealable plastic bag or glass jar with a septum lid.
2. The bag or jar will be tightly sealed (the jar with aluminum foil and plastic lid with septum opening), and the material will be allowed to warm at least to the ambient temperature ( $>32^{\circ}$  F). The sample will be allowed to sit for at least 10 to no more than 60 minutes to allow headspace concentrations to develop, and shaken

periodically for at least 30 seconds at the beginning and end of the development period.

3. The PID/FID probe tip will be inserted into the container within the headspace, with care taken to avoid taking sediment or moisture into the probe.

4. The highest reading (excluding possible erratic readings) on the meter will be recorded for the sample.

5. The deepest sample interval showing a response during headspace screening will be submitted in the initial round of analyses.

#### **4.7 WASTE DISPOSAL**

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Any excess water or sediment remaining after processing will be returned to the river in the vicinity of the collection site. Any water or sediment spilled on the deck of the sampling vessel will be washed into the surface waters at the collection site before proceeding to the next station.

All disposable materials used in sample processing, such as paper towels and disposable coveralls and gloves, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies will be removed from the site by sampling personnel and placed in a normal refuse container for disposal at a solid waste landfill. Phosphate-free, detergent-bearing, liquid wastes from decontamination of the sampling equipment will be washed overboard or disposed of into the sanitary sewer system. Waste solvent rinses will be held in sealed plastic buckets and disposed of into the sanitary sewer. Oily or other obviously contaminated investigation-derived waste will be placed in appropriate containers, and a waste determination will be made before it is disposed of at an appropriate facility.

#### **4.8 SAMPLE HANDLING AND TRANSPORT**

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Since samples collected in support of CERCLA activities may be used in litigation, their possession must be traceable from the time of sample collection through laboratory and data analysis to introduction as evidence. To ensure samples are traceable, the following procedures will be followed.

##### **4.8.1 Chain-Of-Custody Procedures**

Samples are in custody if they are in the custodian's view, stored in a secure place with restricted access, or placed in a container secured with custody seals. A chain-of-custody record will be signed by each person who has custody of the samples

# STANDARD OPERATING PROCEDURE

## PID EQUIPMENT CALIBRATION, OPERATION, AND MAINTENANCE

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### Introduction

The standard operating procedure (SOP) for photoionization detector (PID) equipment calibration describes a procedure to confirm that monitoring equipment used for screening the quality and safety of sediment samples are operating within the manufacturer's specifications.

### Calibration

PIDs will be calibrated on a daily basis each morning prior to making measurements and will be adjusted to operate within the manufacturers' specifications. The PIDs will be calibrated using 100 parts per million (ppm) isobutylene calibration gas provided by the equipment vendor.<sup>1</sup> After calibration, the equipment output will read "Span 1 is done and reading is XXX." Manufacturer states that reading should be close to span gas value. Field crew is using a span gas value of 100 ppm  $\pm$  5%. If readings are outside of this value, then equipment will be sent back to the manufacturer for maintenance. All calibration information shall be recorded in the project logbook.

Special attention shall be noted by field crew to instruments that may be affected by the change in the ambient temperature or humidity. Calibration checks should also be performed when sampling conditions change significantly, sample matrix changes, and/or readings are unstable or there is a change of parameter measurements that appear unusual.

As needed through the day, a black marker may be used to confirm a "positive" reading by the PID instrument.

### Maintenance

All field monitoring equipment and accessories are to be maintained in accordance with the manufacturer's recommendations and specifications and/or established field practices. All maintenance will be performed by qualified personnel and documented in the field logbook or returned to manufacturer for maintenance.

Equipment requiring battery charging shall be charged as recommended by the manufacturer. Backup batteries for meters requiring them shall be included as part of the meters' accessories. Care must be taken to protect meters from adverse elements. Protective measures may involve placing the meter in a large plastic bag to shield it from the weather.

### Documentation

All field equipment calibration, maintenance, and operation information shall be recorded within the field logbook to document that appropriate procedures have been followed and to track the equipment operation.

<sup>1</sup> 100 ppm calibration gas = "Span 1"

Logbook entries shall contain, but are not necessarily limited to, the following:

- Equipment model and serial numbers
- Date and time of calibration or maintenance performed
- Calibration standard used
- Calibration lot number and expiration date if listed on bottle
- Calibration procedure used if there are multiple options
- Calibration and calibration check readings, including units used
- Problems and solutions regarding use, calibration, or maintenance of the equipment
- Other pertinent information

Field records should contain sufficient detail to provide a clear understanding of which equipment was used and how equipment was calibrated. All documentation shall be placed in the project files and retained following completion of the project.

**SOP A-3, SIB Project Area, PHSS**  
**(Source: Sampling Photography)**

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# **STANDARD OPERATING PROCEDURE**

## **CORE PHOTOGRAPHY PROCEDURES FOR SEDIMENT CORING**

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### **Purpose**

The purpose of this standard operating procedure (SOP) is to describe core photography procedures.

### **Scope and Applicability**

This SOP is applicable to taking digital photographs of subsurface sediment cores.

### **Equipment and Materials**

Equipment and materials for taking digital photographs include the following:

- Digital camera
- Spare batteries
- Tripod
- Color calibration card
- Measuring tape
- Light stands
- Digital camera-carrying case and manual
- Photo log form
- Dry-erase board
- Dry-erase marker
- Black waterproof pen

### **Typical Camera Features**

- Save photographs (in standard mode) directly to a memory stick or comparable device
- Auto focus; manual focus available if required
- Zoom
- Brightness control
- Playback of photographs on camera screen
- Display of photograph number, date, and time

- Timed or remote release
- Display showing time remaining on battery and remaining disk capacity
- Ability to protect and delete images that have been taken

## **Camera Use**

A digital camera will be used by the core processing team to photo document the subsurface sediment cores. The field team leader will be responsible for digital photograph documentation or for assigning documentation duties to a team member. Digital photographs will be collected at a high-pixel setting such that enlargements can be made with minimal degradation in picture quality.

## **Photograph Documentation Procedures**

### ***Field Team Responsibilities***

The core processing team will keep a daily hard copy log of all photographs. The following digital photograph data will be collected:

- Date and time—as provided by the camera display
- Team members—list each team member
- Camera identifier (type, model, equipment number)
- Sample Location ID and depth interval
- Photograph ID—record the number of the photograph and the photograph file name (as coded below)
- Description—the target of the photograph

### ***Photography Procedures***

- Sediment cores should be photographed indoors with flood lights and oriented so that shadows are eliminated.
- The camera should be affixed to a tripod and photos taken using a timed or remote release to minimize shaking.
- The axis of the camera lens should be as close to perpendicular as possible to the core to minimize distortion of core and linear features.
- A measuring scale (e.g., tape measure or ruler) should be placed adjacent to the edge of the core as a size reference.
- A color proof strip should be included in the photo to ensure true color reproduction during photo post processing.
- The core Location ID and depth interval should be written onto a dry erase board and included in the photo frame.

### ***Digital Photograph File Name***

At the end of each field day, the member of the field team who is responsible for the camera will transfer the electronic data from the camera to the field operations computer. The folder structure will be as follows (or as specified in the Data Quality Management Plan [DQMP]):

\\DATA\PHOTOS\YYYYMMDD\SAMPLE AREA\file\[1, 2, 3, ....N]

The notation YYYYMMDD represents the year, month, and day. The sample area is the sampling area name (e.g., Willamette River). The individual files for the day (e.g., file 1, file 2, file N) will be placed within this folder using the default file identifier provided by the camera.

### ***Transfer of Information and Archive***

After the photograph disks have been uploaded, the original hard copy of the photograph log will be initialed and dated by the team member who downloaded the photographs, then archived by the field team leader.

### ***Sample Processing Coordinator Responsibilities***

The field team leader will be responsible for 1) reviewing electronic photographs and the logs as they are made available to ensure consistency and completeness of annotations; 2) collecting and archiving the hard copies of the photograph logs; 3) reviewing electronic photographs and the logs as they are made available to ensure consistency and completeness of annotations; and 4) notifying the sampling team leader of apparent inconsistencies and making recommendations for corrective action.

### **Key Checks and Items**

Important checks for digital camera management include the following:

- Make sure the camera's battery is fully charged on a daily basis.
- Keep extra memory sticks available.
- To save battery life, use flash only when necessary.
- Make sure the camera quality level is set at "best" or equivalent (high pixel).
- Review photograph records periodically to ensure that the electronic photographs, dry erase board information, and the Specimen Tally and Location Form agree.
- Leave enough time at the end of the field day to transfer the data.

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**SOP A-4, SIB Project Area, PHSS  
(Source: Storm Drain Sampling)**

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## 1. PURPOSE AND SCOPE

The following text describes the techniques that will be employed to collect sediment samples at specified locations. For the purposes of this project, and where necessary, Apex will adopt the FMC Standard OS-8 Permit Required Confined Space Entry (Attachment A).

## 2. REQUIRED EQUIPMENT

The following equipment and supplies will be used for sediment sample collection:

- Photoionization detectors (PIDs)
- Laboratory-supplied containers
- Decontamination kit (buckets, brushes, Alconox, and tap and deionized water)
- Camera
- Sharpies/pens
- Labels
- Chain-of-Custody forms
- Ice and cooler
- 25-foot grab sample pole with 12-oz. sample cup
- Paper towels
- Personal protective equipment (PPE), including hard hat, boots, high-visibility vest, safety glasses, and nitrile gloves

## 3. SEDIMENT RETRIEVAL METHODS

The methods for retrieving the accumulated sediment are presented below.

- Using safe lifting techniques, traffic controls (if needed), and implementing all health and safety protocols, open the manhole cover.
- Observe sediment volume present. If the volume is adequate for analytical laboratory requirements (8 oz), proceed with sample collection consistent with this SOP.
- Using a grab sample pole fitted with a sample cup or stainless beaker, collect a representative sample by scooping the sediment from the accumulated location.
- Slowly raise the sample cup to the surface and place the sediment into the laboratory-supplied containers (decant water from top).
- Repeat the procedure until the sample container is filled with sediment.
- Label the sample container.
- Close the manhole cover.
- Decontaminate the sample cup before the next location is sampled.



#### **4. DECONTAMINATION PROCEDURES**

Decontamination of sampling equipment must be conducted consistently to ensure the quality of samples collected. Disposable equipment intended for one-time use will not be decontaminated but will be packaged for appropriate disposal.

Decontamination will occur after each use of a piece of equipment between sample locations. All sampling equipment that comes into contact with sampling media (grab pole, stainless beaker, cups, etc.) will be decontaminated according to EPA Region 10 recommended procedures. The following, to be carried out in sequence, is an EPA Region 10 recommended procedure for the decontamination of sampling equipment:

- Non-phosphate detergent and tap water wash, using a brush if necessary
- Tap water rinse
- Deionized/distilled water rinse (first rinse)
- Deionized/distilled water rinse (second rinse)

Equipment will be decontaminated in a predesignated area, and clean bulky equipment items will be stored in their cases or on visqueen in uncontaminated areas. Cleaned small equipment items will be stored in their cases or in plastic bags. Materials to be stored more than a few hours will also be covered.

#### **5. FIELD FORMS**

During each site visit to retrieve accumulated sediment, the field crews will complete a field form which will record the following information:

- Name of staff conducting sampling
- Location
- Date/time of sampling
- Presence and approximate depth of any water at the location
- Approximate volume of sediment sampled
- General comments/observations

#### **6. ATTACHMENTS**

Attachment A FMC Standard OS-8 Permit Required Confined Space Entry

Attachment B Method 166: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels



**SOP A-5, SIB Project Area, PHSS**  
**(Source: Gravity Marine HVS Sampling)**

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## STANDARD OPERATING PROCEDURE (SOP) SW-27

### HIGH-VOLUME STORM WATER SAMPLING FOR ANALYSIS OF COMPOUNDS WITH LOW DETECTION LIMITS

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#### SCOPE AND APPLICATION

This SOP describes the protocol for collecting high-volume (HV) water samples using a Gravity PR2900 pump system coupled with a polyurethane foam (PUF) cartridge and a vortex separator, the collection of parallel peristaltic whole water sample, and the collection of physical sample parameters. This SOP is specific to HV techniques used for storm water sampling and augments information provided in the project planning documents (e.g. Work Plan).

High volume samples (HVS) storm water samples are collected to quantify storm water concentrations of targeted organic chemicals (e.g., dioxins, PCBs, and pesticides) that could be present at levels too low to be detected using conventional sampling methods. This method also allows for quantification of hydrophobic organic chemicals (HOCs) in the suspended particle and dissolved phases.

HV storm water sampling techniques make it possible to obtain enough mass from the storm event to allow quantitation of the target compounds. In summary, a large volume of water is collected with a pump and passed through a vortex separator and then through a cartridge containing PUF material that binds the dissolved forms of the compound in question. The dissolved compounds that bind to adsorbent foam material (i.e. the PUF) are later extracted in the laboratory and measured on a gas chromatograph/mass spectrometer. Trace metal clean sampling techniques are also used for the collection of HV water samples to be analyzed for organic compounds and conventional parameters, such as total suspended solids, dissolved organic carbon, and total dissolved solids. Using these techniques guarantees a high level of sample integrity and minimizes the potential for contamination during sample handling.

This SOP utilizes and augments the procedures outlined in the San Francisco Estuary Institute's *Field Sampling Manual for the Regional Monitoring Program for Trace Substances* (David et al. 2001), the *Interagency Field Manual for the Collection of Water-Quality Data* (USGS, various dates), and U.S. Environmental Protection Agency (EPA) Method 1669, *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels* (USEPA 1996). A goal of this SOP is to ensure that the highest quality, most representative data are collected, and that these data are comparable to data collected by different programs that follow EPA guidelines.

## **STATION ACCESS**

Prior to entering, select areas for storm water sampling that are safe to access. It may be necessary to acquire permission from the landowner to access the property. Access permission must be acquired in advance of the sampling program and may require a written agreement.

## **STATION LOCATION**

Water samples will be collected at specific HVS locations identified in project planning documents (e.g. Work Plan). Samples will be collected over the period of the storm event so it is necessary to ensure that the sample locations have 24/7 access.

## **SUMMARY OF METHOD**

At each station, two lengths of dedicated/new Teflon™ tubing will be attached to a pipe with base mount and flow sensor and lowered into the storm water pipe making sure the tubing does not come into contact with any accumulated sediment. Using a peristaltic pump, the outflow from one of the Teflon™ sampling tubes and is directed into an HVS intake tube, which leads to a high vortex separator. The high vortex separator is able to separate suspended sediments by forcing the water in a centrifugal fashion before exiting towards the 0.45 micron glass filter and then the PUF cartridge. Water is then drawn through the PUF cartridge which contains solid phase extraction resins that bind dissolved forms of the compounds in question (e.g., HOCs). A constant rate of water, 1.5 L/min, is pumped through this system. Every 15 minutes the rate of water pumped is checked to ensure that water is flowing at a constant rate. To check that the pump is accurately delivering the desired rate of volume, the pump outflow must be checked with a 1 L graduated plastic cylinder and a timer. If the pump is not delivering the correct flow rate, fine adjustments must be made until the optimum flow is achieved.

After the desired volume has passed through the PUF cartridge, the HVS peristaltic pump is turned off and the PUF cartridge and the 0.45 micron glass filter are removed. Two stainless steel nuts that cap each end of the PUF cartridge are reattached. The cartridge is then labeled, taped, placed in resealable bags, and placed in a cooler with wet ice. The volume from the vortex separator containing the suspended particles sample is added to the 0.45 micron flat filter, and placed in a labeled 8 oz jar before being placed in a cooler with ice. The vortex sampler volume is removed by shutting the main line valve to the off position and opening the vortex outlet valve while running the pump for 10 seconds.

Physical field measurements and a separate whole water sample can be collected in tandem with the HVS sampling system by connecting the second Teflon™ tube to a secondary peristaltic pump, tubing set and carboy with mixing chamber. This pump will also have a flow-thru chamber with YSI Exo multi-meter installed for continuous measurement of

Dissolved Oxygen, PH, turbidity, and temperature. The second whole water sample can be submitted to the laboratory for analysis in accordance with project planning documents.

## PROCEDURES

The sampling team should comprise two people at each location. Staff are needed to conduct the sampling and keep track of sample logging, data collection and sample processing.

### Equipment Preparation

A sufficient amount of decontaminated sampling equipment will be brought to the field to minimize the amount of decontamination procedures that need to be performed between stations. SGS laboratory is responsible for preparing its equipment prior to delivery. All PUF cartridges will be cleaned, pre-weighed, numbered at the laboratory, and individually packaged before being shipped to the site under chain-of-custody. The list of necessary equipment is provided as Attachment 1 to this SOP.

The following steps are taken to set up the storm water collection system:

1. Assemble and secure the water inlet and tube at the location.
2. Set up a clean area for the sampling equipment.
3. Attach two lengths of Teflon™ tubing (collecting end) to 30-cm platinum cured silicone™ tubing and a 1-m Teflon™ tubing, sequentially, and then connect the platinum cured silicone™ part of these interconnected pieces of tubing firmly into place inside the large peristaltic pump head. The outlet tubing should be directed away from the storm water conveyance to ensure sampled water does not drain back into the outfall. (Note: The length of the Teflon™ tubing will vary depending on project-specific requirements and storm water manhole vault height at a given station).
4. Attach the intake part of the two lengths of Teflon™ tubing to the base mounted pipe with flow sensor to be lowered into the storm water pipe. The pipe with base mount and flow sensor and tubing will then be lowered into the storm water pipe making sure the tubing does not come into contact with any accumulated sediment. The intake tubing shall be pointed in the up-pipe direction.
5. Secure the pumps and pump speed controllers and connect them to a generator or inverter with an extension cord. The generator should be positioned downwind from the sampling and should not be run while the PUF is being transferred to or from the sampler
6. Connect one of the Teflon™ tubes to a flow thru chamber to the whole water physical sample carboy and setup YSI Exo1 for water quality monitoring parameter logging.
7. Connect the other Teflon™ tube to the HVS intake tubing.

## HVS Sample Collection

The following steps are taken to collect and process a standard HVS storm water sample:

1. Remove the protective cap from the sampling tube and lower the pipe with tube gently below the water surface avoiding contact with any accumulated sediment in the storm water pipe.
2. Switch the pump on and purge at least 3 tubing volumes of water through the tubing to ensure a representative sample is collected. During purge, calibrate pump flow rate to 1.5 L/min using a 1 L graduated cylinder.
3. Once purging is complete and flow rates are set, attach tubing outlet to vortex separator and pump storm water through the sample tubing into the vortex separator and through the PUF cartridge at a rate of 1.5 L/min.
4. Every 15 minutes, record pump rate to ensure that the target rate of 1.5 L/min is maintained. If the pump rate falls +/- 5% outside this range (i.e., outside of the range of 1.425 L/min to 1.575 L/min), adjust the speed of the pump.
5. Turn off the pump once the desired volume of storm water has been pumped through the PUF cartridge.
6. Remove the PUF cartridge and cap each end with stainless steel nuts.
7. Remove the 0.45 micron flat filter and place in 8 oz. jar. If multiple flat filters are collected during the sample collection pumping these will be combined in the same 8oz jar for compositing at the testing laboratory.
8. Add the solids from the vortex separator into the flat filter 8 oz. jar by shutting the main line valve to the off position and opening the vortex outlet valve while running the pump for 10 seconds to purge the vortex separator. If needed, rinse the inside of the vortex separator with a squirt bottle filled with deionized water.
9. Attach sampling label, which contains the date, time, project name or number, sample ID, type of analysis required, and sampler initials per project planning documents (e.g. Quality Assurance Project Plan [QAPP])
10. Once the PUF cartridge and solids jar are properly closed and labeled, place them inside a cooler containing wet ice and store at approximately 4°C. All samples are to be stored in coolers with ice prior to submittal and/or shipping to the analytical laboratory, per project planning documents (e.g. QAPP)

## Whole Water Sample Collection

The following steps are taken to collect the whole water storm water sample:

1. Remove the protective cap from the sampling tube and lower the pipe with tube gently below the water surface avoiding contact with any accumulated sediment in the storm water pipe.
2. Switch the pump on and purge at least 3 tubing volumes of water through the tubing to ensure a representative sample is collected. During purge, calibrate pump flow rate to 1.5 L/min using a 1L graduated cylinder.
3. Once purging is complete and flow rates are set, attach tubing outlet to the whole water dedicated carboy with an in-line flow-thru chamber connected to a YSI Exo multi-meter installed for measurement of Dissolved Oxygen, PH, turbidity, and temperature set to be recorded every 15 minutes.
4. Every 15 minutes, collect 1L of whole water into the carboy.
5. Turn off the pump once the desired volume of storm water has been pumped through the HVS system.
6. Attach sampling label to the whole water sample carboy, which contains the date, time, project name or number, sample ID, type of analysis required, and sampler initials per project planning documents (e.g. Quality Assurance Project Plan [QAPP])
7. Once the carboy is properly sealed and labeled, place it on wet ice and store at approximately 4°C. All samples are to be stored on ice prior to submittal and/or shipping to the analytical laboratory, per project planning documents (e.g. QAPP)

## Decontamination

The following steps are taken to decontaminate the HVS and whole water storm water sampling equipment between sample stations. The procedure specific to the HV sampling equipment is provided below.

1. Remove all silicone and Teflon™ tubing from the HVS system and whole water peristaltic pump and discard
2. Plumb decon tubing to system
3. Pump 2 liters of Liquinox® solution through PR2900 system
4. Pump 1 liter of DI water through the PR2900 system
5. Pump 1 liter of Methanol through PR2900 system
6. Pump 1 liter of DI water through PR2900 system
7. Pump 0.5 liter of Hexane through PR2900 system
8. Pump 1 liter of DI water through PR2900 system

9. Cap all exposed inlets and outlets with aluminum foil until next sample is ready for processing

## **WATER QUALITY MEASUREMENTS**

Physical and chemical water parameters will be collected at storm water stations. Several physical and chemical water parameters are best measured in the field because of the unstable nature of the parameter or because the information is needed to direct further sampling. It is frequently preferable to perform these analyses in the field, especially if the samples will not be immediately transported to the analytical laboratory (pH, in particular, should be measured in the field if feasible). A YSI multimeter Exo1 with flow thru chamber will be used to log Dissolved Oxygen, pH, turbidity, and temperature parameters.

The YSI will run for the full duration of the sampling event to observe any potential changes in the physical parameters of the sample. The physical parameter data will be recorded every 15 minutes during sample pumping at each location.

Documentation of instrument information will adhere to project planning documents (e.g. Field Sampling Plan), and at a minimum will contain the name(s) of the person(s) making the measurement and the field equipment used to make that measurement must be recorded in the field logbook and on any field forms used during the sampling event. Equipment maintenance and calibration records must be kept in logbooks and field records so that the procedures are traceable. All field records will be checked by field staff for completeness and electronically provided to the Client.

## **STORMWATER FLOW MEASUREMENT**

A Greyline Stingray 2.0 flow sensor will also be incorporated into the sampling program to measure flow and volume. The flow sensor transmits ultrasonic pulses that travel through the water and reflect off the liquid surface. To monitor water level, the Stingray 2.0 precisely measures the time it takes for echoes to return to the sensor. Velocity is measured with an ultrasonic signal continuously injected into the flow. This high frequency sound is reflected back to the sensor from particles or bubbles suspended in the liquid. If the fluid is in motion, the echoes return at an altered frequency proportionate to flow velocity. The Stingray 2.0 uses this Doppler frequency shift to accurately calculate flow velocity. The Stingray will be attached to the base plate of the pole used to deploy the sampling tube.

The Stingray will run for the full duration of the sampling event to observe any potential changes in the flow. The flow sensor Greyline Logger software will display and record near continuous log files and flow rates in graph and table formats. Flow data reports including minimum, maximum and average flow, and calculated flow totals will be generated.



## SAMPLE HANDLING

Standard “clean and dirty hand” techniques will be observed on this project. Clean hands are required for sample collection and handling, as described above. Field staff will wear appropriate non-contaminating, disposable, powderless nitrile gloves during the entire sampling operation. Gloves will be changed frequently, usually with each change in task (wearing multiple layers of gloves allows rapid glove changes).

*Clean hands* are required for all operations that involve equipment that comes into contact with the sample, including the following activities:

- Handling the PUF column, 0.45 micron flat filter and vortex separator vial
- Handling the intake end of the sample tube or line
- Setting up working space inside the processing chambers
- Setting up the equipment (i.e., HVS sampler and PUF cartridges) inside the chambers
- Handling the vortex separator
- Changing the chamber covers as needed.

*Dirty Hands* take care of all operations that involve contact with potential sources of contamination, including the following activities:

- Working exclusively exterior to the processing and preservation chambers
- Preparing a clean workspace
- Preparing and operating the sampling equipment, including the pumps and discrete samplers
- Handling the generator or other power supply for samplers
- Handling the tools, such as hammers, wrenches, keys, locks, and sample-flow manifolds
- Handling the single or multi-parameter instruments for field measurements
- Setting up and checking the field-measurement instruments
- Measuring and recording the field measurements.

All samples are stored in coolers with ice at approximately 4°C on and transferred to the field facility at the conclusion of the sampling day. The sampling team leader is responsible for maintaining sample integrity throughout the sampling event.

Sample contamination will be avoided by handling the sample containers with clean gloves, and transferring the samples into clean refrigerators (or clean coolers) immediately after samples have been brought back from the field. Sample bottles will always be handled by

personnel wearing disposable, powderless nitrile gloves. This includes any and all sample handling that may occur during sample packing and shipping.

## REFERENCES

David, N., D. Bell, and J. Gold. 2001. Field sampling manual for the Regional Monitoring Program for Trace Substances. San Francisco Estuarine Institute, San Francisco, CA.

USEPA. 1996. Method 1669 - Sampling ambient water for trace metals at EPA water quality criteria levels. U.S. Environmental Protection Agency, Office of Water Engineering and Analysis Division (4303). Washington, DC.

USGS. [various dates]. National field manual for the collection of water-quality data: U.S. Geological Survey techniques of water-resources investigations, Book 9, Chap. A1-A9. Available online at <http://pubs.water.usgs.gov/twri9A>. U.S. Geological Survey. Accessed February 5, 2008, at <http://water.usgs.gov/owq/FieldManual/index.html#Citation>.

## ATTACHMENT 1. FIELD EQUIPMENT LIST

- HV peristaltic pump with vortex separator
- Teflon™ tubing
- YSI Exo1 water parameter multi-meter capable of measuring pH, reduction/oxidation (redox) potential, temperature, specific conductance, turbidity, and dissolved oxygen
- Teflon™-lined polyethylene sample tubing (length is site dependent)
- Platinum cured silicone tubing
- Plastic zip-ties
- Water Sampling Log forms
- Sample tags/labels and appropriate documentation (e.g., chain-of-custody forms)
- Insulated cooler(s), chain-of-custody seals, Ziploc® bags
- Sample containers (PUF cartridges, vortex separator vials)
- Coolers
- Wet ice
- Nitrile gloves
- First aid kit
- Eye wash kit
- Duct tape
- Clear tape
- Packing tape dispenser
- Tool box
- Coated weights for water samplers
- Non-metallic wire for winch spool
- 2000 watt power generator or inverter
- Paper towels
- Dilute solution of Liquinox
- Deionized water
- Extension cord
- Power strip
- Resealable plastic bags (i.e., 1 gallon and 1 quart)
- Yuma Trimble
- IDW containers
- Methanol
- Hexane
- 0.45 micron flat filters

# STANDARD OPERATING PROCEDURE (SOP) SW-31

## SEDIMENT TRAP INSTALLATIONS & REMOVAL

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### SCOPE AND APPLICATION

The following standard operating procedure (SOP) details the steps involved in the installation and removal of sediment traps on the sea floor or river bottom.

#### **Station Access**

Prior to entering select areas such as private beaches, embayments, or proximity to docks, it may be necessary to acquire permission from the landowner to access the property. In addition minimum water depths for vessel traffic need to be considered for each location. Access permission must be acquired in advance of the sampling program and may require a written agreement.

#### **Station Location**

Sediment traps will installed and locations defined in project clients Work Plan.

#### **Positioning & Coordinates**

A differential global positioning system (DGPS) will be used aboard the sampling vessel for accurate station positioning (see project planning documents). Once the vessel is anchored in place, the actual position will be recorded for installed and/or attempted deployment locations. Horizontal coordinates should be recorded in North American Datum of 1983 (NAD83), State Plane Coordinate System – Oregon North, with units in International Feet.

Water depths will be recorded in meters from the vessel bow sonar and with the use of a lead line and converted to NAVD88 using the USGS gauge at the Morrison Street Bridge in Portland, OR..

#### **Safety And Hazardous Materials Management**

General Lab Safety- All general laboratory safety practices will be complied with, including wearing rain gear or lab apron, safety glasses, and gloves. Samples will be treated with regard to possible toxicity and microbiological potential.

This method may involve the use of corrosive and caustic reagents as well as chemicals that pose contact hazards. Care should be taken to avoid skin contact or inhalation of

these chemicals. SOP 28 provides specific methods for the handling of Sodium Azide a preservative used in the sediment traps.

The vessel skipper has ultimate responsibility for safety while the vessel is underway. During deployment of equipment, the operator and the skipper must communicate with one another to avoid potential loss of the instrument due to propeller interface with the underwater field cable.

## **SUMMARY OF METHOD**

Samples will be collected from a vessel at predefined sampling locations. The vessel should be equipped with the necessary equipment to safely operate and navigate and complete the required sampling tasks. Additionally, the proper vessel should be selected for stations in shallow areas which may preclude larger vessels due to draft limitations.

## **PROCEDURES**

The deployment team should comprise two people. The sampling/retrieval team should comprise three people. Two people are needed to conduct the sampling and a third person is required to keep track of sample logging and sample processing. In addition, the third person may be responsible for collecting the data parameters.

### **Equipment**

#### Sediment Trap Design

The sediment trap dimensions, ratio and cluster design, and deployment methods are consistent with methods used in the Portland Harbor Remedial Investigation/Feasibility Study Final Remedial Investigation Report (USEPA, 2016a). The sediment traps, utilized by Gravity are known as the ST-30 design and are the same ones that were used in the PHSS PDI-BL. Sediment traps will consist of four glass tubes sized 15 cm in diameter and 80 cm long mounted upon a common deployment platform constructed of protective polyvinyl chloride rings fastened together. Baffles will not be used. Each tube will contain approximately 1 liter of high salinity water (dense salt) and sodium azide or formalin preservative to help maintain the integrity of the samples and confirm that the cylinder has remained upright during deployment (i.e., check the salinity of the water). Sediment traps are designed with a 5:1 height-to-diameter ratio. The sediment trap is placed above the mudline with the open top of the cylinders 3 feet above the mudline. This height was determined to ensure sediments are collected settling from the water column and not from re-suspension of bedded sediments and has been used effectively at other sites (Norton, 2001).

The following equipment is necessary for sampling surface sediments:

- Sediment Trap

- Timer release – ET100
- Sufficient line to lower instrument to sea floor and retrieve
- Decontamination equipment for cleaning between stations such as Alconox detergent, cleaning brushes, distilled or deionized water
- Nitrile gloves
- Stainless steel utensils for processing
- Subsampling containers for laboratory analysis
- Coolers for sample storage
- DGPS for station positioning
- Field Note Book/ Field Log Sheets

## Trap Installation

Once the vessel has navigated to position and been securely anchored, the traps will be prepared with Sodium Azide and Salt solution and deployed over the side of the vessel. A camera will be utilized to ensure sediment traps are set on the bottom correctly.

Deployment checks:

- Ensure the drag lines are installed at 20' lengths
- Ensure timer is set to appropriate number of days
- Inspect all bolts for tightness
- Test camera prior to deployment

After inspection the traps can be carefully lowered to the seabed. A camera attached to the main winch line will monitor the descent and settling of the traps to ensure they land in a flat spot and are secure. Drag lines at 20' will be set upstream and downstream of the trap as a secondary safety for recovery of the trap array.

## Recording

Information to be recorded during deployment:

- Station ID
- Sampling Vessel
- Name of Sampler
- Station Coordinates (coordinate datum)
- Weather conditions
- Sample time and date
- Water depth
- Camera observations of bottom
- Presence of sheen on water
- Observed debris (wood debris, shell hash...etc)

## Trap Removal

Once the desired trap soak time is complete the samples will be recovered. The vessel will anchor on the actual marked location and prepare for recovery. Assuming the timer for the release is successful the vessel deckhand will hook the recovery line and connect to vessel winch for retrieval. If the release did not occur the deckhand will carefully drag the area near the sampler to recovery one of the two drag lines. Once the trap is collected and on deck each sediment tube will be removed from the array and stored in a rack. The glass tubes will be removed from the assembly, kept upright, and allowed to resettle, if needed. The thickness of accumulated sediment will be measured at multiple points around each tube to account for sloping of sediment within the tube and recorded on the Field Logs. Overlying water will then be siphoned or pumped off from each glass tube. Sediments from each tube will be characterized and described on the Field Logs prior to compositing. Once characterized, sediments will be collected in either a decontaminated stainless-steel bowl or new disposable aluminum pan and homogenized until uniform color and consistency is achieved via mixing with a decontaminated stainless-steel (or disposable) spoon. Once homogenized, sediments will be placed in the appropriate laboratory-provided sampling containers (Table 5) and stored in a cooler at 0 to 6°C until transported to the laboratory. Sample handling and transport procedures outlined in the *QAPP* will be followed.

## Decontamination

The traps will be thoroughly cleaned prior to use between sampling events. The decontamination procedure should follow the following steps:

- Scrub surface with brush and Alconox soap solution.
- Rinse with distilled or deionized water.
- Rinse thoroughly with site water at corresponding location.

All hand work will be conducted with disposable nitrile gloves which will be rinsed with distilled or deionized water before and after handling each individual sample, as appropriate, to prevent sample contamination. Glove will be disposed of between composites to prevent cross contamination between samples.

## DATA QA/QC

To ensure the quality of sample data, a chain of custody (COC) form will be populated to document the samples from the date of collection to the date of receipt by the laboratory. A separate COC form will be created for each cooler listing the sample ID for every container included and the intended analysis.

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**SOP A-6, SIB Project Area, PHSS  
(Source: In-Line Sediment Trap)**

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## 1. PURPOSE AND SCOPE

The following text describes the techniques that will be employed to collect in-line sediments at locations identified in the Pre-Design Investigation (PDI) Work Plan.

## 2. EQUIPMENT

To assess incoming contaminant loads and movement of settleable suspended solids, in-line sediment traps will be deployed and sampled. In-line sediment traps will be installed and retrieved in select locations as described in the PDI Work Plan.

In-line sediment traps addressed by this SOP include the deployment of four 1-Liter HDPE sample bottles held in place with a custom stainless-steel bracket. At each designated sampling location, in-line sediment traps will be installed at the bottom of the conveyance system. In-line sediment traps will be firmly secured to the conveyance system to prevent unintended transport of the equipment. All in-line sediment traps and related equipment will be decontaminated prior to installation.

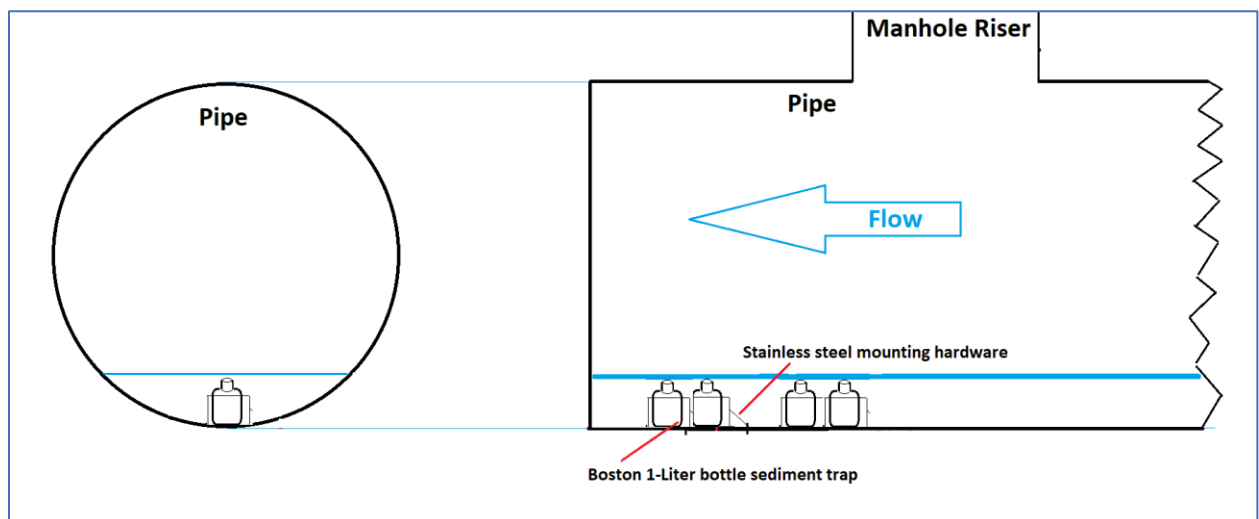
The FMC Standard OS-8 Permit Required Confined Space Entry is included as Attachment A.

## 3. DEPLOYMENT OF SEDIMENT TRAPS

As identified in the PDI Work Plan, in-line sediment trap structures (Boston sediment trap) will be installed (Figure 1). Field crews will perform a confined space entry in accordance with FMC Standard OS-8 Permit Required Confined Space Entry (Attachment A) to install the sediment traps in the flow. A confined space entry will also be required to collect the sediment samples. Each of the 1-liter HDPE sample bottles with removeable Teflon®-lined lids will be held to the bottom of the pipe using custom stainless-steel hardware and brackets (Figure 2).

Sediment traps will be deployed at each location and the sample bottles will be retrieved at the intervals described in the PDI WP. When samples bottles are collected and archived, a clean bottle will be installed in the trap. Sediment samples will be capped, labeled, sealed, and submitted to the laboratory in accordance with the appropriate project planning documents. In general, procedures detailed in this SOP are adopted from the approved Portland Harbor RI/FS Stormwater Field Sampling Plan (LWG 2007; Appendix C).

**Figure 1.** Schematic of deployed Boston sediment trap.



**Figure 2.** Installation photograph of example deployed sediment traps.



#### 4. INSTALLATION METHODS

Experienced field personnel will install the in-line sediment traps using stainless steel hardware and using inert materials. A confined space entry will be required to install the in-line sediment traps. Where traffic controls are required, a traffic control permit will be obtained from the City of Portland. An encroachment permit from the City may also be required to install the in-line sediment traps.

When installing the brackets in the field at the sampling sites, field crews will clean the area around the stainless-steel anchor bolts to remove any concrete dust or debris. After the bolts are set or other procedures are complete, the work site will be scrubbed with a brush to remove any debris and rinsed with deionized water before the sampling hardware (sample bottle holder) is mounted. Care will be taken to capture the rinse water from the work area.

#### 5. LIST OF EQUIPMENT NEEDED FOR IN-LINE SEDIMENT TRAP SAMPLING

The following equipment and supplies will be used for sediment sample collection:

- Photoionization detectors (PIDs)
- Confined space entry and personnel retrieval equipment
- Laboratory-supplied 1-Liter sample bottles
- Decontamination kit (buckets, brushes, Alconox, and tap and deionized water)
- Camera
- Sharpies/pens
- Labels
- Chain-of-Custody forms
- Ice and cooler
- Paper towels
- Personal protective equipment (PPE), including hard hat, boots, safety glasses, high-visibility vest, nitrile gloves, and ear plugs for drilling activities
- Confined space entry PPE per FMC Standard OS-8 Permit Required Confined Space Entry (Attachment A).

## 6. SEDIMENT RETRIEVAL METHODS

In accordance with the PDI WP, the sediment traps will be collected and archived in the analytical laboratory and a clean bottle will be installed to the trap bracket. The methods for retrieving the accumulated sediment are presented below. A confined space entry will be performed to retrieve sediment samples according to these instructions:

- Using safe lifting techniques, traffic controls (if needed), and implementing all health and safety protocols, open the manhole cover.
- Perform the confined space entry into the manhole and prepare to retrieve the sediment trap bottles.
- Implement “clean hands – dirty hands” method (EPA 1996; Attachment B) for collecting samples.
- Use phthalate-free vinyl gloves to place the Teflon lids on the sample bottles.
- Remove the sample bottle from the bracket and transfer each bottle to the surface.
- Label the bottle, pack on ice, and prepare for transport to the analytical laboratory.
- Place new laboratory-provided 1-Liter sample bottles back into the brackets, remove the lids, and store the lids in a phthalate-free bag.
- Exit the confined space and replace the manhole cover.

## 7. DECONTAMINATION PROCEDURES

Decontamination of sampling equipment must be conducted consistently to ensure the quality of samples collected. Disposable equipment intended for one-time use will not be decontaminated but will be packaged for appropriate disposal.

Decontamination will occur prior to each use of a piece of equipment. All sampling devices that potentially contact sampling media (grab pole, stainless beaker, cups, etc.) will be decontaminated according to EPA Region 10 recommended procedures (Attachment B). The following, to be carried out in sequence, is an EPA Region 10 recommended procedure for the decontamination of sampling equipment:

- Non-phosphate detergent and tap water wash, using a brush if necessary
- Tap water rinse
- Deionized/distilled water rinse (first rinse)
- Deionized/distilled water rinse (second rinse)

Equipment will be decontaminated in a predesignated area, and clean bulky equipment items will be stored in their cases or on visqueen in uncontaminated areas. Cleaned small equipment items will be stored in their cases or in plastic bags. Materials to be stored more than a few hours will also be covered.

## 8. FIELD FORMS

During each site visit to retrieve accumulated sediment, the field crews will complete a field form which will record the following information:

- Name of staff conducting downloading
- Location
- Date/time of sampling
- Approximate volume of sediment sampled
- Condition of the sediment traps
- General comments/observations

## 9. ATTACHMENTS

Attachment A FMC Standard OS-8 Permit Required Confined Space Entry

Attachment B Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels

**SOP A-7, SIB Project Area, PHSS**  
**(Source: Horizontal and Vertical Control)**

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# **STANDARD OPERATING PROCEDURE**

## **HORIZONTAL AND VERTICAL SURVEY**

### **CONTROL**

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#### **Introduction**

This Standard Operating Procedure (SOP) has been developed for the Pre-Remedial Design Sampling and Baseline Investigations (PDI) at the Portland Harbor Superfund Site located in Portland, Oregon to confirm accurate positioning of vessels and samples during sample collection activities. The survey control requirements described in this SOP are specifically for environmental sample collection and will generally comply with map-grade precision and accuracy in contrast to the geodetic-grade precision and accuracy performed for the Bathymetric Survey conducted by David Evans and Associates (DEA). However, the same survey control points and geodetic parameters will be used in both surveys for consistency, and a portion of the quality assurance/quality control (QA/QC) process will involve consultation with DEA Oregon Professional Land Surveyor (PLS) staff to review the map-grade data collected for the environmental sample collection.

The organization of this SOP is as follows:

- Methodology Overview
- Project Geodetic Parameters
- Survey Accuracy, Precision, and Control
- Primary Equipment
- Hand-Held GPS Operation
- Vessel Navigation and Equipment Operation
- Data Processing and QA/QC Procedures

Tables, figures, and attachments are presented at the end of the SOP.

#### **Methodology Overview**

##### ***Horizontal (Map) Data Collection***

A combination of vessel-mounted and hand-held GPS receivers will be used to navigate to sampling locations and to collect map location coordinates (Northings, Eastings) for those sampling locations. The vessel-mounted GPS receivers will be the primary tool used for navigation to the pre-planned sampling locations in a GIS file, which will be pre-loaded into the vessel navigational system. The hand-held GPS devices will be used as a backup and confirmation of vessel position only if there are problems with the vessel GPS navigation system or if there is no specific vessel navigation system (i.e., smaller boats). Since the inception of field work, the vessel GPS coordinates have been consistently verified and deemed to be sufficient to meet position and accuracy requirements for the project. The hand-held GPS devices will primarily be used for studies involving small vessels. These devices will also have the pre-loaded basemap content depicting planned sampling locations.

The vessel GPS will operate in two modes, collecting both a separate continuous data stream of positional information (line file) and recording GPS soundings (target file) when a sample is specifically

collected. The sample location target file will be recorded when the sampling device is in position for the grab (e.g., when sampler is on the river bottom). The specific Location ID associated with the sample will also be recorded in the GPS device log. Field personnel will be required to write that same Location ID on their field data collection forms at the same time. Both the continuous and episodic dataset will be timestamped to allow comparison of the two types of data. This data will be recorded and maintained on the vessel, and will also be exported from the vessel navigation system and archived to project servers on a daily basis.

The hand-held GPS devices will be operated independently of the vessel's systems and will be used to record a location sounding wherever a sample is collected only for studies unable to use the vessel GPS navigation system. The sample location sounding will be recorded approximately at the same time as when the vessel GPS measurement is collected (e.g., when sampler is in position). The specific Location ID associated with the sample will also be recorded on the GPS device. Field personnel will write this Location ID on the field forms only if the vessel measurement described earlier cannot be collected for some reason (e.g., equipment failure). These measurements will also be timestamped. The data from the hand-held GPS devices will be wirelessly synchronized to a "cloud" web service in near real-time; the data from the "cloud" will also be downloaded and saved to project servers daily.

### ***Vertical Data Collection***

Vertical (elevation) data is also required for water levels, sample collection depth below surface water, and bottom (mudline) depth location for some types of sample locations. For increased precision and accuracy, it is proposed that bottom (mudline) depth locations (e.g., for sediment cores) be calculated from the bathymetric surface to be developed by the hydrographic survey performed by DEA (since the data will be collected within a few months of each other). The NAVD88 elevation will be calculated from the intersection of the surface map location coordinates collected as described earlier, projected vertically down to the bathymetric surface (United States Army Corps of Engineers [USACE], 2004). The elevation from the intersection of the bathymetric surface will be used as the final or "best" elevation for the sample.

In contrast, for depth measurements that require less precision (e.g., water levels, depth to samples below water surface), the onboard vessel sonar will be used to record depth and then subsequently calculate elevation. All depths will be recorded relative to the water surface and time tagged to correct with time tagged gauge data for obtaining riverbed elevations. The elevation will be calculated to NAVD88 datum. To correct elevations, gauge data from the Northwest River Forecast Center will be downloaded for gauge PRT03, which is representative of the former Morrison gauge which has been moved. This gauge does not report NAVD88 elevations but rather reports a value that is 0.3 feet above Columbia River Datum (CRD). Corrections from CRD to NAVD88 differ moving down the river from the gauge due to the fact that NAVD88 is a reference normal to gravity (water does not flow if the elevation is unchanging), and CRD is a gradient datum that follows the lower water surface. In Portland Harbor, the difference between CRD and NAVD88 (Geoid12b) ranges from 0.00 feet CRD = -5.16 feet NAVD88 (Geoid12b) at Willamette River river mile (RM) 2.0, to 0.00 feet CRD = -5.41 feet NAVD88 (Geoid12b) at Willamette River RM 12.8 (approximate location of PRT03 Gauge). Accordingly, a correction to the Willamette Gauge in Portland would be -5.41+0.3 or -5.11 feet at RM 12.8. An approximation would be to subtract 5 feet from the gauge reading for the full length of the

study area, but precision will vary depending on tides and river gradient.

For sample locations requiring vertical information, depth will be recorded by field staff on their data collection forms relative to the water surface, and these values will be loaded to the project database as described in the Data Quality Management Plan (DQMP). Final calculated NAVD88 elevation data (feet) will also be entered into a separate data field in the project database after completion of spatial analysis, calculations, and QA/QC. DEA will provide support during the QA/QC process to verify proper calculation of NAVD88 elevation data.

### ***Location Position Recording in Project Database***

#### **Discrete Samples**

When discrete samples are collected, the Location ID and the location coordinates (Northing/Easting) will be recorded on the GPS device(s) and the field data collection form(s). The location coordinates will be based on the vessel GPS instantaneous target measurement. This target measurement will be the location coordinate pair loaded initially to the project database. After the field event is completed, the target measurement will be compared to the line file (vessel continuous GPS measurement) to confirm that the coordinate pair loaded to the project database is appropriate. If analysis reveals precision or accuracy issues, the loaded location coordinate pair in the project database may be updated and edited with a better value derived from the line file. In general, the hand-held GPS devices will be used as a backup and confirmation of vessel position only if there are problems with the vessel GPS navigation system or an independent navigation system is not available on the vessel. These coordinates will be loaded to the project database only if there is a significant problem with the vessel GPS (e.g., equipment failure) or if there is no vessel GPS.

#### **Composite Samples**

When composite samples are collected, location coordinates will also be recorded as both target measurements and continuous measurements using the vessel GPS. The continuous GPS measurements will be recorded during the entire compositing event, and instantaneous target measurements will be collected when the sampler is in position for each individual composite grab. At each compositing location, a target measurement will be recorded in the vessel GPS along with the Location ID with an “a,” “b,” or “c” suffix. These measurements will be recorded on the field forms in the same manner (e.g., there will be three sets of location coordinates, lithologic descriptions, etc.).

When the location data is loaded to the project database, a single set of location coordinates will be recorded in the project database with a Location ID that excludes the “a,” “b,” or “c” suffix. As a presumed middle time point, the “b” set of coordinates will be loaded with the primary Location ID to the project database. After the field event is completed, the target measurement associated with the “b” location composite will be compared to the line file (vessel continuous GPS measurement) to assess vessel position and the timeframe of the entire sampling event to confirm if the coordinate pair loaded to the project database is appropriate. The goal will be to finalize the location coordinate information in the project database based on the most representative position based on this analysis. Similar to discrete sample collection, a hand-held GPS device and related data will only be loaded to the project database if there is a significant problem with operation of the vessel GPS or if the vessel does not have a GPS.

Finally, after field data are collected and surveys are completed, as defined in the DQMP, the location coordinate data will be joined with the tabular data collected by the field teams and loaded to the project database.

### **Project Geodetic Parameters**

The geodetic parameters to be used for the PDI field studies will be as follows:

***Horizontal Datum:*** North American Datum of 1983 (2011)

***Projection:*** State Plane Coordinate System (SPCS) Oregon North Zone

***Vertical Datum:*** North American Vertical Datum of 1988 (NAVD88) Geoid12b

***Units:*** International Feet

### **Survey Accuracy, Precision, and Control**

The anticipated horizontal accuracy of environmental sampling associated with vessel and hand-held GPS devices is a range of 1 to 5 meters (target 1 to 2 meters for the DGPS unit itself). This should be consistent with RI target accuracy (Integral 2002) and best practices (Puget Sound Estuary Protocols [PSEP] 1998 and US Environmental Protection Agency [EPA] 2008).

The anticipated vertical accuracy of final elevation calculations derived from vessel sonar systems is anticipated to be 1.0 meter.

Table 1 summarizes the survey control locations used in the DEA Bathymetric Survey, which will be used for the environment sample collection work described in this SOP. Figure 1 shows the PH2 piling at Fred Devine boat dock, and Figure 2 shows the approximate locations of the survey control references. Attachment 1 contains detailed survey sheets of the control points: Raindeer, PH1 and PH2, and 2100.

### **Primary Equipment**

- Trimble® SPS 461 GPS with dual antennas (vessel GPS)
- A-frame assembly, sampling winch (vessel boom)
- Trimble® R1 (hand held GPS), tethered to Bluetooth® capable smartphone or tablet, ESRI Collector software with Trimble® GNSS Status middleware
- GPS owner's manual
- Writing tools (pencils, Sharpie®)
- Field logbook
- Spare batteries and/or battery charger
- Compass
- Tape measure

### **Hand-Held GPS Operations**

For ease of use, the project team will utilize smartphones tethered to the Trimble® R1 GNSS Receiver via a Bluetooth® connection. The smartphone will be configured with Trimble's middleware software called GNSS Status to convert and stream NMEA satellite data to the smartphone for real-time

correction and display to a simple electronic data collection form developed on the ESRI Collector platform. The form will contain a limited number of data fields, including location, study name and operator, date, and notes or comments. This form is not intended to duplicate the content and scope of the field data collection forms, but rather clearly link the GPS data to those forms via the unique Location ID. There are metadata fields available as well from these GPS records, such as estimated horizontal accuracy.

Collected data recorded onto the phone will be transmitted wirelessly via a synchronization process invoked when data is “saved” to the device. The data will be pushed to AECOM Online’s Portal and ArcGIS Server for storage of “corrected” location coordinates, Location ID, and other information captured when the GPS sounding is recorded. The sampling event will be trackable in near-real-time as samples are collected on the ArcGIS Portal Interface. Either dedicated, experienced GPS-operators will be collecting the measurements on the smartphones, or, due to the very simple nature of the interface, field personnel will be trained to use the devices. Initial training sessions were already successfully conducted March 19-20, 2018 on use of the smartphone GPS interface. These handheld devices were successfully used for the first 2 weeks of field work. For some studies, such as the smallmouth bass tracking study, these handhelds may be used as the primary GPS due to smaller vessel configuration.

### **Vessel Navigation and Equipment Operation**

Vessel positioning will be conducted through the marine navigation and hydrographic software package HYPACK. This software package allows the visualization of the vessel over navigable charts, the processing of satellite corrections, stored hardware, and vessel parameters, as well as the storing of physical target locations during sampling activities. HYPACK version 2017 will be used for this project.

Vessel position is measured using a Trimble SPS 461 GPS dual antenna receiver. The dual antennas provide precise vessel positioning via both satellite and differential radio corrections along with heading correction to 0.09 degree. GPS data is output through a serial connection into computer running the HYPACK software, for vessel positioning and target collection.

At each sampling location, depth to mudline will be measured using an onboard fathometer (with lead line as confirmation as needed) immediately prior to or during the sampling. Water depths are measured at each station using an Airmar ss510 survey sonar at the sampling point and confirmed daily with a lead line with reference to water surface. Vertical measurements will be recorded to the nearest 0.1 foot. Water depths will be converted to elevations in NAVD88 based on the river stage at the time of sampling as recorded at the closest available tide gage.

### **Data Processing and QA/QC Procedures**

All GPS devices will be subject to a position check to confirm the accuracy of the on-vessel GPS and hand-held GPS devices and to validate the positions derived from each GPS receiver. Correctors being applied as needed, resulting in a position that is within specified positioning accuracy of the DEA published position for control monument PH1 and PH2. At the start and end of each field day, the PH2 benchmark location will be visited by boat to perform a position check. At the piling serving as the control monument, the on-vessel GPS calibrated to the top of A-frame assembly will be maneuvered as close to the benchmark piling as possible to record a point. The GPS-derived position

of the sampling vessel is compared with the known horizontal location; results will be recorded in HYPACK to confirm that accuracy is within +/- 2 meters. For handheld GPS, field staff will occupy the PH1 at the Swan Island boat launch parking lot. Using the R1 and phone/tablet combination GPS setup, the field staff will hold the R1 above PH1 and wait for a satellite “fix,” and when ready, the staff will record the GPS location in Collector. This GPS location will be compared to the known coordinates to confirm the accuracy is within +/- 2 meters. The survey control monuments act as a known location to allow for corrected station location coordinates during post-processing of data as needed. If a need arises to locate another benchmark, there are several USGS control points near the project area and near the AECOM project warehouse. Experienced GPS operators on the project team will be involved in all aspects of field data collection events to troubleshoot devices and assist in daily review of extracted geospatial datasets. Additional details on QA/QC procedures can be found on the DQMP.

## **References**

- AECOM (AECOM Technical Services) and Geosyntec (Geosyntec Consultants, Inc.). 2018. Data Quality Management Plan Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling. Portland Harbor Superfund Site. 22 February.
- Integral (Integral Consulting). 2002. Round 1 Field Sampling Plan. Prepared for the Lower Willamette Group (LWG) for submittal and approval by EPA Region 10. June 14.
- EPA (United States Environmental Protection Agency). 2008. National Geospatial Data Policy. August 24.
- PSEP. 1998. Recommended Guidelines for Station Positioning in Puget Sound. Prepared for United States EPA Region 10 and the Puget Sound Water Quality Action Team. September.
- USACE (United States Army Corps of Engineers). 2004. Engineering and Design Hydrographic Surveying Manual, EM 1110-2-1003, U.S. Army Corps of Engineers, April 2004

## **Attachments**

PH Control Points of 2100, Portland Harbor (PH1 and PH2), and Raindeer survey monuments, as well as figures presenting PH2.

**Table 1. Benchmark Monument Coordinates and Description**

Designation	Approx. Location	Description	NAD83 (2011), Oregon SPCS North (ft)		NAVD88 Elevation (ft)
			Northing	Easting	
DEMSI-BASE	Columbia River	Fixed antenna with height at antenna reference point	718172.70	7654431.05	73.58
DEMSI- CHECK	Columbia River	Fixed antenna with height at antenna reference point	718170.73	7654419.84	71.67
RAINDEER	RM 2	USACE Brass Cap	722443.24	7614886.64	35.44
Portland Harbor (PH1)	Swan Island Boat Ramp	1/2" Iron Rod with red plastic cap stamped "DEA Control" Point is 0.3 feet south of the back of curb at the Swan Island Boat Ramp, 10.5 feet north of a cyclone fence, and 60 feet east of a light post	698702.46	7637426.37	33.38
Portland Harbor 2 (PH2)	Fred Devine Boat Dock	Reference point is 0.2 feet SE of the SE side of a 1-1/2 foot steel pile. This is the furthest SE pile at the end of the Fred Devine Diving and Salvage Company dock in the Swan Island Lagoon. This pile is to be used for daily position checks for sediment sampling operations. Pile is for position only and not elevation.	700967.87	7634507.67	NA
2100	RM 13	5/8" bolt on SW corner of screen wall at DEA office 2100 SW River Parkway, Portland, OR	678400.01	7645190.81	159.51

**General Notes:**

1. The two DEMSI and the 2100 stations are transceiver beacon stations in upland areas (Green Shade).
2. PH1 is located at the Swan Island boat ramp parking lot and accessible by foot.
3. PH2 is located at a piling at the boat dock where project-related vessels will be docked and is accessible by boat.
4. Raindeer station is located adjacent to the river and accessible by foot (for the hand-held GPS).

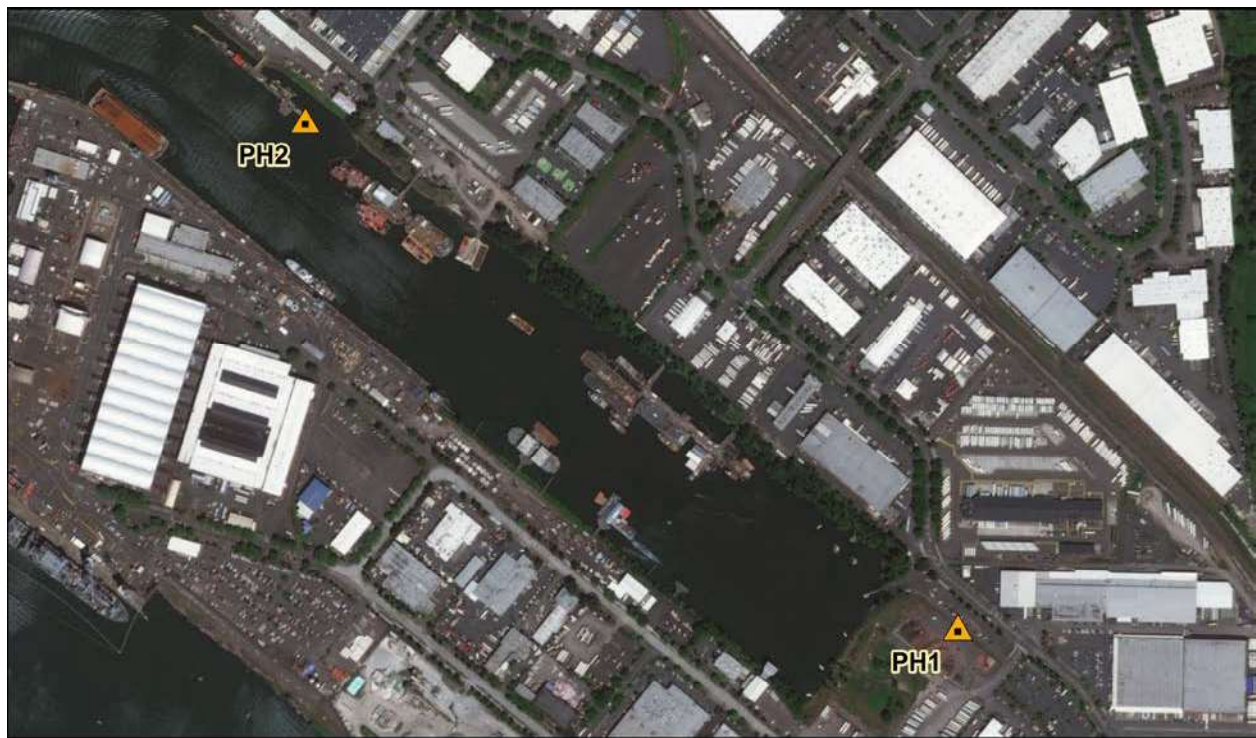
**Acronyms:**

DEA = David Evans and Associates; ft = feet; NAD83 = North American Datum of 1983; NAVD88 = North American Vertical Datum of 1988; PH = Portland Harbor; RM = river mile; USACE = US Army Corps of Engineers; SPCS = State Plane Coordinate System



**Figure 1. Photograph of Piling PH2, at the end of the Fred Devine Boat Dock. Piling was captured in DEA bathymetric survey. Photo is facing northwest.**





Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N  
0 250 500 1,000  
Feet




PH2 is located on the SE corner of the Fred Devine Boat Dock, where Gravity's boats berth every night.



PH1 is located on the SW side of the Swan Island Boat Launch parking lot, where field crews park to meet the boats at the launch dock.

**Figure 2. Locations of control monuments PH1 and PH2 at Swan Island Boat Launch and Fred Devine Boat Dock, respectively.**

NOTE: This form intended for field use. Unsolicited data submitted to NGS must be converted to bluebook format.

 <b>GPS STATION OBSERVATION LOG</b> April 16, 2003	Station Designation: (check applicable: __ FBN__ CBN__ PAC__ SAC__ BM) <div style="text-align: center; font-size: 1.2em;">2100</div>		Station PID, if any:		Date (UTC): <div style="text-align: center; font-size: 1.2em;">06-Mar-18</div>						
	General Location: <b>DEA Office 2100 SW River Parkway, Portland</b>		Airport ID, if any:		Station 4-Character ID:						
Project Name: <div style="text-align: center; font-size: 1.2em;">Portland Harbor - AETR00000034</div>		Project Number: <div style="text-align: center; font-size: 1.2em;">GPS-</div>		Station Serial # (SSN):		Session ID:(A,B,C etc)					
NAD83 Latitude <div style="text-align: center;">o ' "</div>		NAD83 Longitude <div style="text-align: center;">o ' "</div>		NAD83 Ellipsoidal Height <div style="text-align: center;">meters</div>		Agency Full Name: <b>David Evans and Associates, Inc.</b> Operator Full Name: <div style="text-align: right; font-size: 1.2em;">David T. Moehl</div> <div style="text-align: right; font-size: 1.2em;">(360) 314-3200</div> Phone #: (      ) e-mail address: <b>dtm@deainc.com</b>					
Observation Session Times (UTC): Sched. Start _____ Stop _____		Epoch Interval= <u>1</u> Seconds Elevation Mask = <u>10</u> Degrees		NAVD88 Orthometric Ht. <div style="text-align: center;">meters</div>							
Actual Start <u>18:55</u> Stop <u>23:00</u>		GEOID99 Geoid Height <div style="text-align: center;">meters</div>									
Receiver Brand & Model: <div style="text-align: center; font-size: 1.2em;">Trimble SPS855</div> <div style="text-align: center; font-size: 1.2em;">69855-60</div> P/N: <div style="text-align: center; font-size: 1.2em;">5506R0075</div> S/N: Firmware Version: <div style="text-align: center; font-size: 1.2em;">5.30</div>		Antenna Code*, Brand & Model: <div style="text-align: center; font-size: 1.2em;">Trimble Zephyr 3 Base</div> <div style="text-align: center; font-size: 1.2em;">115000-10</div> P/N: <div style="text-align: center; font-size: 1.2em;">3121179869</div> S/N: Cable Length, meters: <div style="text-align: center; font-size: 1.2em;">10</div>		Antenna plumb before session? <input checked="" type="checkbox"/> (Y/N) Circle Antenna plumb after session? <input checked="" type="checkbox"/> (Y/N) Yes or No Antenna oriented to true North? (Y/N) <input checked="" type="checkbox"/> -If no, Weather observed at antenna ht. (Y/N) <input checked="" type="checkbox"/> explain Antenna ground plane used? (Y/N) <input checked="" type="checkbox"/> "  Antenna radome used? (Y/N) <input checked="" type="checkbox"/> If yes, Eccentric occupation (>0.5 mm)? (Y/N) <input checked="" type="checkbox"/> describe. Any obstructions above 10'? (Y/N) <input checked="" type="checkbox"/> Use Radio interference source nearby (Y/N) <input checked="" type="checkbox"/> Vis. form							
<input type="checkbox"/> CamCorder Battery, <input type="checkbox"/> 12V DC, <input checked="" type="checkbox"/> 110V AC, <input type="checkbox"/> Other		Vehicle is Parked <u>n/a</u> meters ____ (direction) from antenna.									
Tripod or Antenna Mount: Check one: <input type="checkbox"/> Fixed-Leg Tripod, <input type="checkbox"/> Collapsible-leg tripod, <input checked="" type="checkbox"/> Fixed Mount Brand & Model: <b>Bolt</b> P/N: S/N: Last Adjustment date: _____  Psychrometer (if used) Brand & Model:  P/N: S/N: Last Calibration or check Date: _____			** ANTENNA HEIGHT **		<b>Before Session Begins:</b> Meters      Feet		<b>After Session Ends:</b> Meters      Feet				
			<b>A=</b> Datum point to Top of Tripod (Tripod Height)		0.000		0.000				
			<b>B=</b> Additional offset to ARP if any (Tribrach/Spacer)		0.000		0.000				
			<b>H=</b> Antenna Height = <b>A + B</b> <b>=</b> Datum Point to Antenna Reference Point (ARP)		0.000	0.00	0.000	0.00			
			Meters = Feet x (0.3048) Height Entered Into Receiver = <u>0.000</u> meters.		Note &/or sketch <b>ANY</b> unusual conditions. Be <b>Very Explicit</b> as to where and how Measured!						
Barometer (if used) Brand & Model:  S/N:		Weather Data	Weather Codes	Time (UTC)	Dry-Bulb Temp Fahrenheit   Celsius		WetBulb Temp Fahrenheit   Celsius		Rel. % Humidity	Atm. Pressure inches Hg   millibar	
		Before	00000	18:55							
		Middle									
		After	00000	23:00							
Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc: <div style="padding: 10px; font-size: 1.1em;">           5/8" bolt found on the southeast corner of the VAC screen wall on DEA office roof at 2100 SW River Parkway, Portland, OR. The geodetic antenna was screwed tight to the top of the double nut on the 5/8" bolt. The antenna height = zero to the antenna reference point (bottom of antenna mount).         </div> <div style="margin-top: 10px; font-size: 0.9em;">           Weather codes are required. Weather data are optional but encouraged. *Antenna code comes from ant_info file furnished by project coordinator.         </div>											
Data File Name(s): <b>00750650.T02</b> <small>(Standard NGS Format = aaaadddd.xxx)          where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension</small>					Updated Station Description: <input type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Visibility Obstruction Form: <input type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Photographs of Station: <input checked="" type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Pencil Rubbing of Mark: <input type="checkbox"/> Attached				LOG CHECKED BY: <div style="text-align: center; font-size: 1.2em;">Jon Dasler</div>		
Table of Weather Codes	CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND					
	0	did not occur	Good, over 15 miles	Normal, 32° F- 80° F	Clear, below 20%	Calm, under 5mph (8km/h)					
	1	did occur	Fair, 7-15 miles	Hot, over 80°F (27 C)	Cloudy, 20% to 70%	Moderate, 5 to 15 mph					
	2	- not used -	Poor, under 7 miles	Cold, below 32° F (0 C)	Overcast, over 70%	Strong, over15 mph (24km/h)					
Examples:      00000 = No problem, good visibility, normal temp, clear, calm wind      12121 = Problems, poor visibility, hot, overcast, moderate wind											

**Photo of Monument 2100**

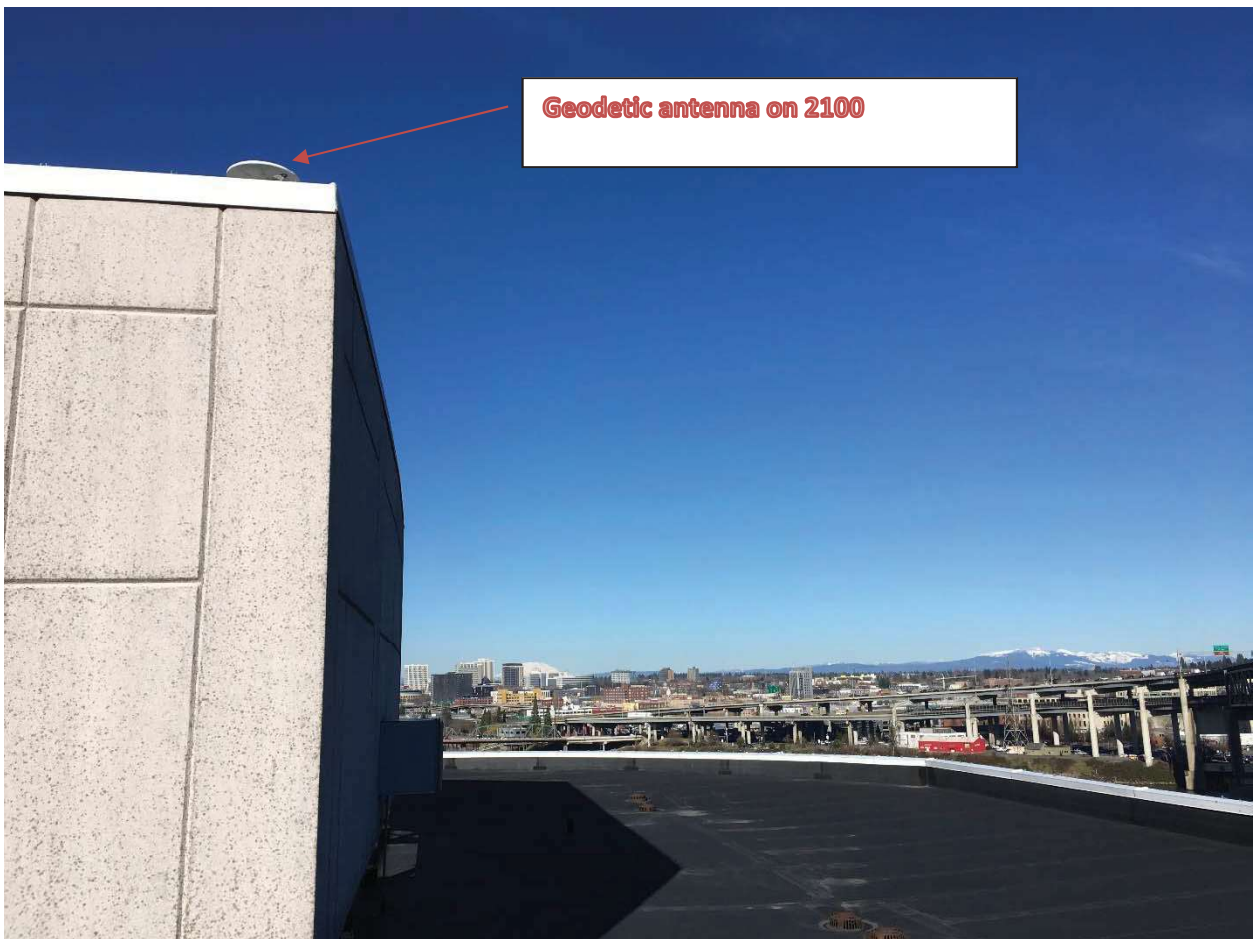




**Photo of Monument 2100**




**GNSS Setup on 2100**

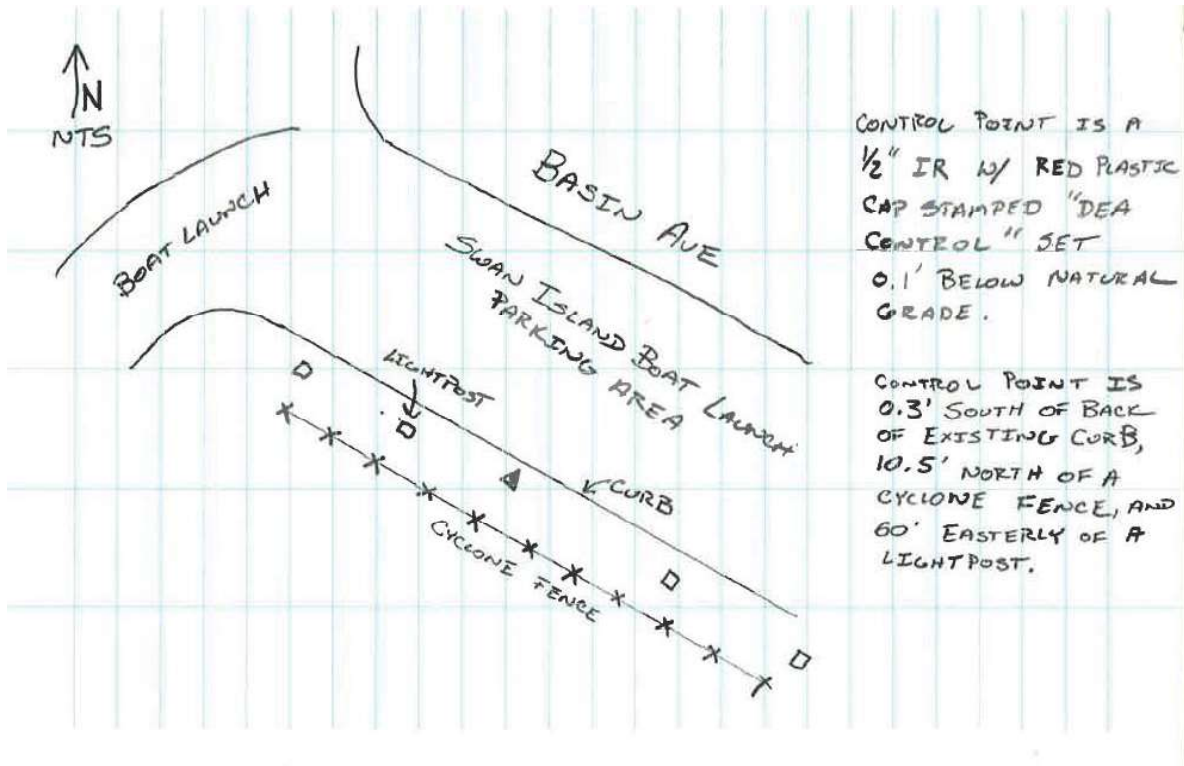


**Geodetic antenna on 2100**

NOTE: This form intended for field use. Unsolicited data submitted to NGS must be converted to bluebook format.

 <b>GPS STATION OBSERVATION LOG</b> April 16, 2003	Station Designation: (check applicable: __ FBN__ CBN__ PAC__ SAC__ BM) <b>Portland Harbor 1 (PH1)</b>		Station PID, if any:		Date (UTC): <b>06-Mar-18</b>										
	General Location: <b>Swan Island Boat Launch</b>		Airport ID, if any:		Station 4-Character ID: Day of Year: <b>065</b>										
Project Name: <b>Portland Harbor - AETR00000034</b>			Project Number: <b>GPS-</b>		Station Serial # (SSN): Session ID:(A,B,C etc)										
NAD83 Latitude 0		NAD83 Longitude 0		NAD83 Ellipsoidal Height meters NAVD88 Orthometric Ht. meters GEOID99 Geoid Height meters		Agency Full Name: <b>David Evans and Associate, Inc.</b> Operator Full Name: <b>David T. Moehl</b> Phone #: ( ) <b>(360) 314-3200</b> e-mail address: <b>dtm@deainc.com</b>									
Observation Session Times (UTC): Sched. Start Stop Actual Start <b>19:30</b> Stop <b>21:32</b>		Epoch Interval= <b>1</b> Seconds Elevation Mask = <b>10</b> Degrees													
Receiver Brand & Model: <b>Trimble SPS985</b> <b>82500-60</b> P/N: S/N: <b>5616F59510</b> Firmware Version: <b>5.30</b> <input type="checkbox"/> CamCorder Battery, <input type="checkbox"/> 12V DC, <input type="checkbox"/> 110V AC, <input checked="" type="checkbox"/> Other		Antenna Code*, Brand & Model: <b>Trimble SPS985 Internal</b> P/N: S/N: Cable Length, meters: <b>n/a</b> Vehicle is Parked <b>10</b> meters <b>N</b> (direction) from antenna.		Antenna plumb before session? <input checked="" type="checkbox"/> (Y/N) Circle Antenna plumb after session? <input checked="" type="checkbox"/> (Y/N) Yes or No Antenna oriented to true North? <input checked="" type="checkbox"/> (Y/N) -If no, explain Weather observed at antenna ht. <input checked="" type="checkbox"/> (Y/N) Antenna ground plane used? <input checked="" type="checkbox"/> (Y/N) Antenna radome used? <input checked="" type="checkbox"/> (Y/N) If yes, describe. Eccentric occupation (>0.5 mm)? <input checked="" type="checkbox"/> (Y/N) Use Any obstructions above 10'? <input checked="" type="checkbox"/> (Y/N) Vis. form Radio interference source nearby <input checked="" type="checkbox"/> (Y/N)											
Tripod or Antenna Mount: Check one: <input checked="" type="checkbox"/> Fixed-Leg Tripod, <input type="checkbox"/> Collapsible-leg tripod <input type="checkbox"/> Fixed Mount Brand & Model: <b>Seco fixed height</b> P/N: S/N: <b>5115-00-FLY</b> Last Adjustment date: <b>2018-03-05</b> Psychrometer (if used) Brand & Model: P/N: S/N: Last Calibration or check Date:		<b>** ANTENNA HEIGHT **</b> <b>A=</b> Datum point to Top of Tripod (Tripod Height) <b>B=</b> Additional offset to ARP if any (Tribrach/Spacer) <b>H=</b> Antenna Height = <b>A + B</b> <b>=</b> Datum Point to Antenna Reference Point (ARP) Meters = Feet x (0.3048) Height Entered Into Receiver = <b>2.000</b> meters. Note &/or sketch <b>ANY</b> unusual conditions. Be <b>Very Explicit</b> as to where and how Measured!		<b>Before Session Begins:</b> Meters Feet <b>2.000</b> <b>0.000</b> <b>2.000</b> <b>6.56</b> <b>2.000</b> <b>6.56</b>		<b>After Session Ends:</b> Meters Feet <b>2.000</b> <b>0.000</b> <b>2.000</b> <b>6.56</b>									
Barometer (if used) Brand & Model: S/N:		Weather Data Before Middle After		Weather Codes 00000 00000		Time (UTC) 19:30 21:32		Dry-Bulb Temp Fahrenheit Celsius		WetBulb Temp Fahrenheit Celsius		Rel. % Humidity		Atm. Pressure inches Hg millibar	
Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc: <b>Control point is a 1/2" iron rod with red plastic cap stamped "DEA CONTROL" set 0.1' below natural grade. Control point is 0.3' south of the back of curb, 10.5' north of a cyclone fence and 60' easterly of the 2nd light post east of the boat ramp. See detached sketch and photos.</b>															
Weather codes are required. Weather data are optional but encouraged. *Antenna code comes from ant_info file furnished by project coordinator.															
Data File Name(s): <b>95100650.T02</b> (Standard NGS Format = aaaaddds.xxx) where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension								Updated Station Description: <input type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Visibility Obstruction Form: <input type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Photographs of Station: <input checked="" type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Pencil Rubbing of Mark: <input type="checkbox"/> Attached				LOG CHECKED BY: <b>Jon Dasler</b>			
Table of Weather Codes		CODE		PROBLEM		VISIBILITY		TEMPERATURE		CLOUD COVER		WIND			
		0		did not occur		Good, over 15 miles		Normal, 32° F- 80° F		Clear, below 20%		Calm, under 5mph (8km/h)			
		1		did occur		Fair, 7-15 miles		Hot, over 80°F (27 C)		Cloudy, 20% to 70%		Moderate, 5 to 15 mph			
		2		- not used -		Poor, under 7 miles		Cold, below 32° F (0 C)		Overcast, over 70%		Strong, over15 mph (24km/h)			
Examples: 00000 = No problem, good visibility, normal temp, clear, calm wind 12121 = Problems, poor visibility, hot, overcast, moderate wind															

## Sketch of Monument PH1






**Photo of Monument PH1**



**GNSS Setup on PH1**

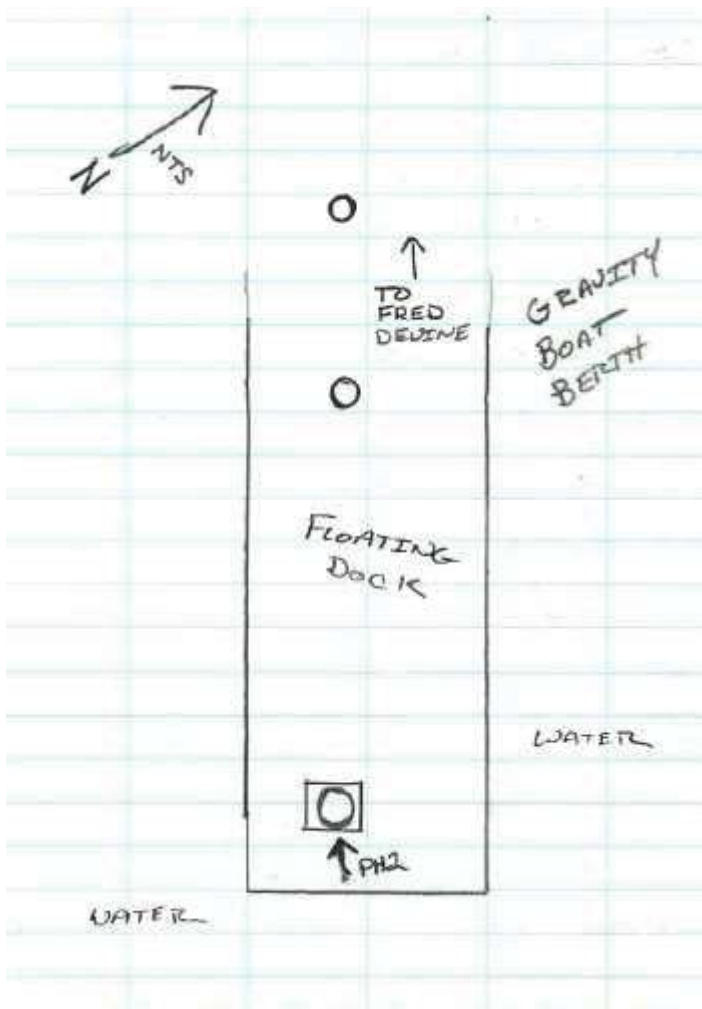


NOTE: This form intended for field use. Unsolicited data submitted to NGS must be converted to bluebook format.

 GPS STATION OBSERVATION LOG April 16, 2003	Station Designation: (check applicable: __ FBN__ CBN__ PAC__ SAC__ BM) <b>Portland Harbor 2 (PH2)</b>		Station PID, if any:		Date (UTC): <b>20-Apr-18</b>			
	General Location: <b>Fred Devine Boat Dock</b>		Airport ID, if any:		Station 4-Character ID: <b>111</b>			
Project Name: <b>Portland Harbor - AETR00000034</b>			Project Number: <b>GPS-</b>		Station Serial # (SSN): Session ID:(A,B,C etc)			
NAD83 Latitude o ' "		NAD83 Longitude o ' "		NAD83 Ellipsoidal Height meters		Agency Full Name: <b>David Evans and Associate, Inc.</b>		
Observation Session Times (UTC): Sched. Start _____ Stop _____		Epoch Interval= <u>1</u> Seconds		NAVD88 Orthometric Ht. meters		Operator Full Name: <b>David T. Moehl</b>		
Actual Start <b>19:45</b> Stop <b>19:49</b>		Elevation Mask = <u>10</u> Degrees		GEOID99 Geoid Height meters		Phone #: ( ) <b>(360) 314-3200</b>		
Receiver Brand & Model: <b>Trimble SPS985</b> <b>82500-60</b> P/N: S/N: Firmware Version: <b>5.30</b>		Antenna Code*, Brand & Model: <b>Trimble SPS985 Internal</b> P/N: S/N: Cable Length, meters: <b>n/a</b>		Antenna plumb before session? (Y / N) <input checked="" type="checkbox"/> Circle Antenna plumb after session? (Y / N) <input checked="" type="checkbox"/> Yes or No Antenna oriented to true North? (Y / N) <input checked="" type="checkbox"/> -If no, Weather observed at antenna ht. (Y / N) <input checked="" type="checkbox"/> explain Antenna ground plane used? (Y / N) <input checked="" type="checkbox"/> "		e-mail address: <b>dtm@deainc.com</b>		
<input type="checkbox"/> CamCorder Battery, <input type="checkbox"/> 12V DC, <input type="checkbox"/> 110V AC, <input checked="" type="checkbox"/> Other		Vehicle is Parked <u>n/a</u> meters _____(direction) from antenna.		Antenna radome used? (Y / N) <input checked="" type="checkbox"/> If yes, Eccentric occupation (>0.5 mm)? (Y / N) <input checked="" type="checkbox"/> describe. Any obstructions above 10'? (Y / N) <input checked="" type="checkbox"/> Use Radio interference source nearby (Y / N) <input checked="" type="checkbox"/> Vis. form				
Tripod or Antenna Mount: Check one: <input checked="" type="checkbox"/> Fixed-Leg Tripod, <input type="checkbox"/> Collapsible-leg tripod, <input type="checkbox"/> Fixed Mount Brand & Model: <b>Seco fixed height</b> P/N: S/N: Last Adjustment date: <b>2018-03-05</b>			<b>** ANTENNA HEIGHT **</b>		<b>Before Session Begins:</b> Meters Feet		<b>After Session Ends:</b> Meters Feet	
Psychrometer (if used) Brand & Model: P/N: S/N: Last Calibration or check Date:			<b>A= Datum point to Top of Tripod (Tripod Height)</b>		<b>2.000</b>		<b>2.000</b>	
			<b>B=Additional offset to ARP if any (Tribrach/Spacer)</b>		<b>0.000</b>		<b>0.000</b>	
			<b>H= Antenna Height = A + B</b> <b>= Datum Point to Antenna Reference Point (ARP)</b>		<b>2.000</b>		<b>6.56</b>	
			Meters = Feet x (0.3048) Height Entered Into Receiver = <b>2.000</b> meters.		Note &/or sketch <b>ANY</b> unusual conditions. Be <b>Very Explicit</b> as to where and how Measured!			
Barometer (if used) Brand & Model:		Weather Data	Weather Codes	Time (UTC)	Dry-Bulb Temp Fahrenheit Celsius	WetBulb Temp Fahrenheit Celsius	Rel. % Humidity	Atm. Pressure inches Hg millibar
S/N:		Before	00010	19:45				
		Middle						
		After	00010	19:49				
Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:  <b>Reference point is 0.2 feet SE of the SE side of a 1-1/2 foot steel pile. This is the furthest SE pile at the end of the Fred Devine Diving and Salvage Company dock in the Swan Island Lagoon. This pile is to be used for daily position checks for sediment sampling operations. Pile is for position only and not elevation. NAD83(2011) Oregon North Zone International Feet Coordinates North 700967.9 East 7634507.7</b>  Weather codes are required. Weather data are optional but encouraged. *Antenna code comes from ant_info file furnished by project coordinator.								
Data File Name(s): (Standard NGS Format = aaaadddd.xxx) where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension				Updated Station Description: <input type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Visibility Obstruction Form: <input type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Photographs of Station: <input checked="" type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Pencil Rubbing of Mark: <input type="checkbox"/> Attached			LOG CHECKED BY: <b>Jon Dasler</b>	
Table of Weather Codes	CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND		
	0	did not occur	Good, over 15 miles	Normal, 32° F- 80° F	Clear, below 20%	Calm, under 5mph (8km/h)		
	1	did occur	Fair, 7-15 miles	Hot, over 80°F (27 C)	Cloudy, 20% to 70%	Moderate, 5 to 15 mph		
	2	- not used -	Poor, under 7 miles	Cold, below 32° F (0 C)	Overcast, over 70%	Strong, over15 mph (24km/h)		
Examples: 00000 = No problem, good visibility, normal temp, clear, calm wind 12121 = Problems, poor visibility, hot, overcast, moderate wind								



## Sketch and Fieldnotes

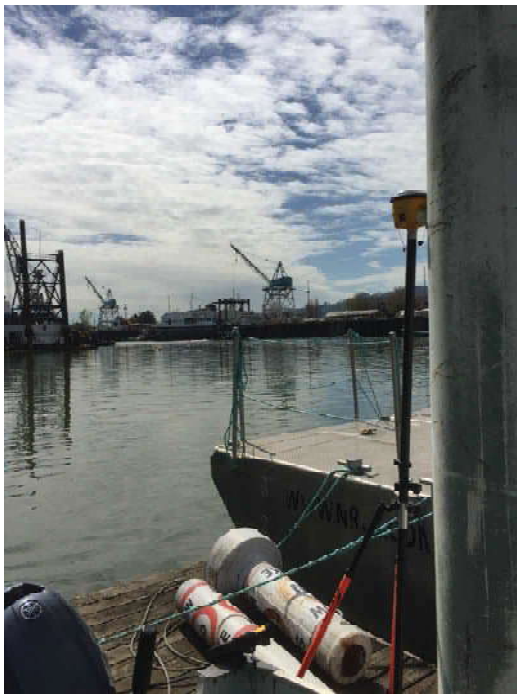


200	CHK PHI		
	KNOWN COORDS	OBS	$\Delta$ (FT)
	N = 698702.46	N = 698702.45	0.01
	E = 7637426.37	E = 7637426.39	0.02
	Z = 33.38	Z = 33.37	0.01
201	SE FACE OF PILE		
	3-MIN OBS		
	N = 700967.87		
	E = 7634507.67		
	Z = N/A		
202	SW FACE	TOP	
203	NW FACE	TOP	
204	NE FACE	TOP	

## Overview of PH2 Pile



## GNSS Setup on PH2 Pile



View facing south



View facing northwest

NOTE: This form intended for field use. Unsolicited data submitted to NGS must be converted to bluebook format.


 GPS STATION OBSERVATION LOG April 16, 2003	Station Designation: (check applicable: __ FBN__ CBN__ PAC__ SAC__ BM) <b>Raindeer</b>		Station PID, if any:		Date (UTC): <b>06-Mar-18</b>							
	General Location: <b>Sauvie Island, Willamette River</b>		Airport ID, if any:		Station 4-Character ID: <b>065</b>							
Project Name: <b>Portland Harbor - AETR00000034</b>			Project Number: <b>GPS-</b>		Station Serial # (SSN): Session ID:(A,B,C etc)							
NAD83 Latitude o ' "		NAD83 Longitude o ' "		NAD83 Ellipsoidal Height meters		Agency Full Name: <b>David Evans and Associates, Inc.</b>						
Observation Session Times (UTC): Sched. Start _____ Stop _____		Epoch Interval= <u>1</u> Seconds		NAVD88 Orthometric Ht. meters		Operator Full Name: <b>David T. Moehl</b>						
Actual Start <b>17:38</b> Stop <b>23:45</b>		Elevation Mask = <u>10</u> Degrees		GEOID99 Geoid Height meters		Phone #: ( ) <b>(360) 314-3200</b>						
Receiver Brand & Model: <b>Trimble SPS855</b>		Antenna Code*, Brand & Model: <b>Trimble Zephyr 3 Base</b>		Antenna plumb before session? <input checked="" type="checkbox"/> (Y/N) Circle		e-mail address: <b>dtm@deainc.com</b>						
P/N: <b>69855-60</b>		P/N: <b>115000-00</b>		Antenna plumb after session? <input checked="" type="checkbox"/> (Y/N) Yes or No		Weather observed at antenna ht. (Y/N) <input checked="" type="checkbox"/> explain						
S/N: <b>5506R0074</b>		S/N: <b>1551129193</b>		Antenna oriented to true North? <input checked="" type="checkbox"/> (Y/N) explain		Antenna ground plane used? (Y/N) <input checked="" type="checkbox"/>						
Firmware Version: <b>5.30</b>		Cable Length, meters: <b>10</b>		Antenna radome used? (Y/N) <input checked="" type="checkbox"/> If yes, describe.		Eccentric occupation (>0.5 mm)? (Y/N) <input checked="" type="checkbox"/> Use						
<input type="checkbox"/> CamCorder Battery, <input checked="" type="checkbox"/> 12V DC, <input type="checkbox"/> 110V AC, <input type="checkbox"/> Other		Vehicle is Parked <u>n/a</u> meters ____ (direction) from antenna.		Any obstructions above 10'? (Y/N) <input checked="" type="checkbox"/> Vis. form		Radio interference source nearby (Y/N) <input checked="" type="checkbox"/>						
Tripod or Antenna Mount: Check one: <input checked="" type="checkbox"/> Fixed-Leg Tripod, <input type="checkbox"/> Collapsible-leg tripod, <input type="checkbox"/> Fixed Mount Brand & Model: <b>Seco fixed height</b> P/N: S/N: Last Adjustment date: <b>5115-00-FLY</b> <b>2018-03-05</b> Psychrometer (if used) Brand & Model:  P/N: S/N: Last Calibration or check Date:			<b>** ANTENNA HEIGHT **</b>		<b>Before Session Begins:</b>		<b>After Session Ends:</b>					
					Meters		Feet		Meters		Feet	
			<b>A=</b> Datum point to Top of Tripod (Tripod Height)		<b>2.000</b>				<b>2.000</b>			
			<b>B=</b> Additional offset to ARP if any (Tribrach/Spacer)		<b>-0.003</b>				<b>-0.003</b>			
			<b>H=</b> Antenna Height = <b>A + B</b> = Datum Point to Antenna Reference Point (ARP)		<b>1.997</b>		<b>6.55</b>		<b>1.997</b>		<b>6.55</b>	
			Meters = Feet x (0.3048) Height Entered Into Receiver = <b>2.000</b> meters. Note &/or sketch <b>ANY</b> unusual conditions. Be <b>Very Explicit</b> as to where and how Measured!									
Barometer (if used) Brand & Model:  S/N:		<b>Weather Data</b>	<b>Weather Codes</b>	<b>Time (UTC)</b>	<b>Dry-Bulb Temp</b> Fahrenheit Celsius		<b>WetBulb Temp</b> Fahrenheit Celsius		<b>Rel. % Humidity</b>	<b>Atm. Pressure</b> inches Hg millibar		
		<b>Before</b>	<b>00000</b>	<b>17:38</b>								
		<b>Middle</b>										
		<b>After</b>	<b>00000</b>	<b>23:45</b>								
Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:												
Weather codes are required. Weather data are optional but encouraged. *Antenna code comes from ant_info file furnished by project coordinator.												
Data File Name(s): <b>00740650.T02</b> (Standard NGS Format = aaaaaddss.xxx) where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension					Updated Station Description: <input type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Visibility Obstruction Form: <input type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Photographs of Station: <input checked="" type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Pencil Rubbing of Mark: <input type="checkbox"/> Attached				LOG CHECKED BY: <b>Jon Dasler</b>			
<b>Table of Weather Codes</b>	<b>CODE</b>	<b>PROBLEM</b>	<b>VISIBILITY</b>	<b>TEMPERATURE</b>	<b>CLOUD COVER</b>		<b>WIND</b>					
	<b>0</b>	did not occur	Good, over 15 miles	Normal, 32° F- 80° F	Clear, below 20%		Calm, under 5mph (8km/h)					
	<b>1</b>	did occur	Fair, 7-15 miles	Hot, over 80°F (27 C)	Cloudy, 20% to 70%		Moderate, 5 to 15 mph					
	<b>2</b>	- not used -	Poor, under 7 miles	Cold, below 32° F (0 C)	Overcast, over 70%		Strong, over15 mph (24km/h)					
Examples: 00000 = No problem, good visibility, normal temp, clear, calm wind 12121 = Problems, poor visibility, hot, overcast, moderate wind												



Photo of Monument RAINDEER





**Photo of Monument RAINDEER**





## GNSS Setup on RAINDEER



## **APPENDIX B**

### **FIELD SAMPLING FORMS**

1. Daily Equipment Calibration Log
2. Waste Tracking Log
3. Bank Erosion Hazard Index
4. Physical Shoreline Inspection Form
5. Near-Bank Stress Risk

(Individual SOPs also include forms to be used, which are not listed here)

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## Daily Equipment Calibration Log

**Project Name:** \_\_\_\_\_

**Project Number:** \_\_\_\_\_

[illegible]

## Waste Tracking Log

[illegible]

**Worksheet 3-11.** Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

Bank Erosion Hazard Index (BEHI)																																									
Stream:					Location:																																				
Station:					Observers:																																				
Date:			Stream Type:			Valley Type:																																			
<div style="text-align: right; font-weight: bold; margin-bottom: 10px;">BEHI Score (Fig. 3-7)</div> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p style="text-align: center; font-weight: bold;">Study Bank Height to Bankfull Height ( C )</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">Study Bank Height (ft) =</td> <td style="width: 20%; text-align: center;">(A)</td> <td style="width: 20%;">Bankfull Height (ft) =</td> <td style="width: 20%; text-align: center;">(B)</td> <td style="width: 20%;"><math>(A) / (B) =</math></td> <td style="width: 20%; text-align: center;">(C)</td> </tr> </table> <p style="text-align: center; font-weight: bold;">Root Depth to Study Bank Height ( E )</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">Root Depth (ft) =</td> <td style="width: 20%; text-align: center;">(D)</td> <td style="width: 20%;">Study Bank Height (ft) =</td> <td style="width: 20%; text-align: center;">(A)</td> <td style="width: 20%;"><math>(D) / (A) =</math></td> <td style="width: 20%; text-align: center;">(E)</td> </tr> </table> <p style="text-align: center; font-weight: bold;">Weighted Root Density ( G )</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">Root Density as % =</td> <td style="width: 20%; text-align: center;">(F)</td> <td style="width: 20%;"><math>(F) \times (E) =</math></td> <td style="width: 20%; text-align: center;">(G)</td> </tr> </table> <p style="text-align: center; font-weight: bold;">Bank Angle ( H )</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">Bank Angle as Degrees =</td> <td style="width: 20%; text-align: center;">(H)</td> </tr> </table> <p style="text-align: center; font-weight: bold;">Surface Protection ( I )</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">Surface Protection as % =</td> <td style="width: 20%; text-align: center;">(I)</td> </tr> </table> </div> <div style="width: 50%; padding-top: 20px;"> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p><b>Bank Material Adjustment:</b></p> <p><b>Bedrock</b> (Overall Very Low BEHI)</p> <p><b>Boulders</b> (Overall Low BEHI)</p> <p><b>Cobble</b> (Subtract 10 points if uniform medium to large cobble)</p> <p><b>Gravel or Composite Matrix</b> (Add 5–10 points depending on percentage of bank material that is composed of sand)</p> <p><b>Sand</b> (Add 10 points)</p> <p><b>Silt/Clay</b> (no adjustment unless primarily clay, then subtract 20 points)</p> </div> <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="width: 40%; border: 1px solid black; padding: 5px;"> <p style="text-align: center; font-weight: bold;">Bank Material Adjustment</p> </div> <div style="width: 55%; border: 1px solid black; padding: 5px;"> <p style="text-align: center; font-weight: bold;">Stratification Adjustment</p> <p>Add 5–10 points, depending on position of unstable layers in relation to bankfull stage</p> </div> </div> </div> </div> <div style="display: flex; justify-content: space-between; align-items: center; margin-top: 10px;"> <table border="1" style="width: 60%; border-collapse: collapse; text-align: center;"> <tr> <td style="width: 16.6%;">Very Low</td> <td style="width: 16.6%;">Low</td> <td style="width: 16.6%;">Moderate</td> <td style="width: 16.6%;">High</td> <td style="width: 16.6%;">Very High</td> <td style="width: 16.6%;">Extreme</td> </tr> <tr> <td>5 – 9.5</td> <td>10 – 19.5</td> <td>20 – 29.5</td> <td>30 – 39.5</td> <td>40 – 45</td> <td>46 – 50</td> </tr> </table> <div style="width: 35%; text-align: center;"> <p style="font-weight: bold;">Adjective Rating and Total Score</p> </div> </div>										Study Bank Height (ft) =	(A)	Bankfull Height (ft) =	(B)	$(A) / (B) =$	(C)	Root Depth (ft) =	(D)	Study Bank Height (ft) =	(A)	$(D) / (A) =$	(E)	Root Density as % =	(F)	$(F) \times (E) =$	(G)	Bank Angle as Degrees =	(H)	Surface Protection as % =	(I)	Very Low	Low	Moderate	High	Very High	Extreme	5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50
Study Bank Height (ft) =	(A)	Bankfull Height (ft) =	(B)	$(A) / (B) =$	(C)																																				
Root Depth (ft) =	(D)	Study Bank Height (ft) =	(A)	$(D) / (A) =$	(E)																																				
Root Density as % =	(F)	$(F) \times (E) =$	(G)																																						
Bank Angle as Degrees =	(H)																																								
Surface Protection as % =	(I)																																								
Very Low	Low	Moderate	High	Very High	Extreme																																				
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50																																				
<div style="display: flex;"> <div style="flex: 1;"> <p style="text-align: center; font-weight: bold;">Bank Sketch</p> </div> <div style="flex: 1;"> </div> </div>																																									

## Physical Shoreline Inspection Form

### SIB Project Area, Portland Harbor Superfund Site

This field form was developed from the *Guidance for River Bank Characterizations and Evaluations at the Portland Harbor Superfund Site* (USEPA, 2019) (Guidance). An assessment using this form must be completed for each geomorphic area or segment of the river bank with different physical and material characteristics because of the unique potential for erodibility each segment possesses. For further detail regarding Physical Shoreline Inspection requirements, please refer to Section 2.3 of the Guidance. As needed, information to complete this form may need to be obtained from topographic or bathymetric surveys or from available online reference for Portland Harbor, such as USGS gauging stations.

Prepared by: \_\_\_\_\_ Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_ Date: \_\_\_\_\_

<b>River Mile Segment:</b>			
<b>Use of river bank segment:</b>			
<b>Bank Angle:</b>			
<b>Alignment of the River:</b>			
<b>Width and Depth of the River:</b>			
<b>Stream Velocity and Stage:</b>			
<b>Wind- and Boat-Induced Waves?</b>			
<b>River Bank Surface Protection:</b>			
Type of Surface Protection (woody debris, rooted vegetation, embedded boulders, revetment, bedrock, etc.):	% of Bank Covered by Surface Protection	Location of protection relative to the toe of the slop, top of the bank, and OHW elevation	
Type and Size of Armoring (riprap, rock, gravel, concrete, gabions, retaining walls, etc.):	% of Bank Covered by Armoring	Condition of armoring (stable, unstable, sloughing into river, etc.)	Location of armoring relative to the toe of the slop, top of the bank, and OHW elevation

**Physical Shoreline Inspection Form**  
**SIB Project Area, Portland Harbor Superfund Site**

River Bank Vegetation Type:	% of Bank Covered by Vegetation	Root Depth (depth relative to bank height in %):	Root Density (% of bank surface covered by roots):
<b>River Bank Soil Types classified using the Unified Soil Classification System determined by ASTM D2488:</b>			
Bedrock %:	Cobble %:		Sand or mostly sand %:
Boulders %:	Gravel or mostly gravel %:		Silt or clay %:
<b>Bank stratification (circle one):</b>	No layers	Single layer of erodible material	Multiple layers of erodible material
<b>Visible indicators of active river bank erosion due to overland flow, wave and/or vessel wake, or other factors?</b> Describe and document via photograph and GPS coordinates when possible.			
<b>Evidence of previous river bank SCMs. Describe current integrity in providing protection against erosion.</b>			
<b>Presence of Aquatic Vegetation?</b>		Yes	No
<b>GPS points collected within tenth of RM:</b>			
Location ID	Description of point:		Photo Taken (Y/N)?
<b>Additional Notes/Observations:</b>			

**Worksheet 3-12.** Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate an erosion rate.

Estimating Near-Bank Stress ( NBS )									
Stream:				Location:					
Station:				Stream Type:			Valley Type:		
Observers:				Date:					
Methods for Estimating Near-Bank Stress (NBS)									
(1) Channel pattern, transverse bar, or central bar creating NBS				Level I		Reconnaissance			
(2) Radius of curvature to bankfull width ( $R_c / W_{bkf}$ )				Level II		General Prediction			
(3) Pool slope to average water surface slope ( $S_p / S$ )				Level II		General Prediction			
(4) Pool slope to riffle slope ( $S_p / S_{rif}$ )				Level II		General Prediction			
(5) Near-bank maximum depth to bankfull mean depth ( $d_{nb} / d_{bkf}$ )				Level III		Detailed Prediction			
(6) Near-bank shear stress to bankfull shear stress ( $\tau_{nb} / \tau_{bkf}$ )				Level III		Detailed Prediction			
(7) Velocity profiles / Isovels / Velocity gradient				Level IV		Validation			
Level I	(1)	Transverse or central bars - short or discontinuous.....				NBS = <b>High / Very High</b>			
		Extensive deposition (continuous, cross-channel).....				NBS = <b>Extreme</b>			
		Chute cutoffs, down-valley meander migration, converging flow.....				NBS = <b>Extreme</b>			
Level II	(2)	Radius of Curvature $R_c$ (ft)	Bankfull Width $W_{bkf}$ (ft)	Ratio $R_c / W_{bkf}$	Near-Bank Stress (NBS)	<div style="border: 1px solid black; padding: 10px; display: inline-block;"> <b>Dominant Near-Bank Stress</b> </div>			
	(3)	Pool Slope $S_p$	Average Slope $S$	Ratio $S_p / S$	Near-Bank Stress (NBS)				
	(4)	Pool Slope $S_p$	Riffle Slope $S_{rif}$	Ratio $S_p / S_{rif}$	Near-Bank Stress (NBS)				
Level III	(5)	Near-Bank Max Depth $d_{nb}$ (ft)	Mean Depth $d_{bkf}$ (ft)	Ratio $d_{nb} / d_{bkf}$	Near-Bank Stress (NBS)				
	(6)	Near-Bank Max Depth $d_{nb}$ (ft)	Near-Bank Slope $S_{nb}$	Near-Bank Shear Stress $\tau_{nb}$ ( lb/ft <sup>2</sup> )	Mean Depth $d_{bkf}$ (ft)	Average Slope $S$	Bankfull Shear Stress $\tau_{bkf}$ (lb/ft <sup>2</sup> )	Ratio $\tau_{nb} / \tau_{bkf}$	Near-Bank Stress (NBS)
Level IV	(7)	Velocity Gradient ( ft / sec / ft )		Near-Bank Stress (NBS)					
Converting Values to a Near-Bank Stress (NBS) Rating									
Near-Bank Stress (NBS) Ratings		Method Number							
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	
<b>Very Low</b>		N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50	
<b>Low</b>		N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00	
<b>Moderate</b>		N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60	
<b>High</b>		See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00	
<b>Very High</b>		(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40	
<b>Extreme</b>		Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40	
Overall Near-Bank Stress (NBS) Rating									